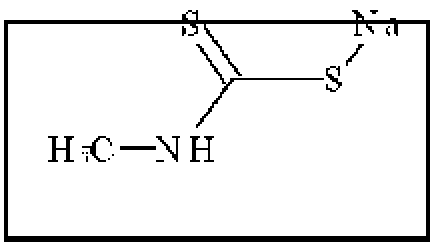
United States Environmental Protection Agency

Office of Prevention, Pesticides, and Toxic Substances

Environmental Fate and Ecological Risk Assessment for the Existing Uses of Metam-sodium



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I. Environmental Risk Conclusions

Metam-sodium is a widely used fumigant on agricultural and non agricultural sites. It is highly unstable in the environment, degrades rapidly to form methyl isothiocyanate (MITC), which acts as preplant soil sterilant to control nematodes, soil-borne diseases, insects and weeds**.** Metam potassium is the potassium salt analog of metam sodium. Since, these chemicals have virtually identical physical-chemical properties and a similar use profile, the ecological risk assessment of metam sodium should be applicable to metam potassium. The high vapor pressure and low affinity for sorption on soil of MITC suggest that volatilization is the most important environmental route of dissipation and to a lesser extent leaching and degradation. Rapid photolytic decomposition of gaseous MITC is the primary route of dissipation from the atmosphere. Repeated application of metam sodium at the same site may cause microbial induced fast degradation of MITC resulting in the compromise of biocidal activities of metam sodium.

The major concern with metam-sodium is the exposure of terrestrial and aquatic organisms to the degradate MITC. Based on a preliminary LD50/square foot risk assessment screen, acute Levels of Concern (LOC) are substantially exceeded for mammals. A refined analysis using mammal inhalation data and both monitoring and modeling data for air residues of MITC, however, does not indicate an acute risk concern for wild mammals. Since the refined analyses were performed with the data derived from off-site locations at certain heights (**.** 2.0 meter), EFED may have underestimated the acute risk to mammals. Additional on-site ground-level air monitoring data may reduce the uncertainty of the refined risk analyses for mammals. Avian toxicity data are needed for a complete assessment for birds. There is also a potential for exposure over a prolonged period. Birds and mammals could have territories or home ranges in the area and be exposed substantially and/or repeatedly, due to the use of metam-sodium on multiple fields over multiple days in any given geographic area. Acute aquatic LOCs are exceeded for both aquatic invertebrates and fish in all modeled scenarios except potatoes. Atypical wet year conditions may have influenced the PRZM/EXAMS's predicted EECs of MITC for the selected scenarios, and consequently impacted the acute exposure assessments of the aquatic organisms.

Metam sodium degrades rapidly in soil (aerobic soil half-live, 23 minutes) to generate (MITC), a volatile biocidal active product. Once MITC volatilizes into the atmosphere, it degrades rapidly due to direct photolysis (photolysis in air half-life, 29 to 39 hours). Several minor degradates of MITC were identified that include methyl isocyanate (MIC), hydrogen sulfide (H_2S), and others resulting from the direct photolysis in a laboratory experiment.

Several air monitoring studies suggest that the metam sodium application methods affected the volatility rates of MITC and consequently dictated the ambient residue of MITC and its metabolites in the air samples. Air monitoring in California shows the highest MITC concentration occurred during metam sodium application through a sprinkler irrigation followed by water-sealing. The concentrations of MITC in air samples ranged from 78.3 to 2450 ppb at 5 meters from the field edge and 11.7 to

1320 ppb at 150 meters from the field edge. The concentrations of H_2S and MIC were also detected in the air samples during the application and post application of metam sodium. MIC is known to be very toxic to animals. However, MIC concentrations in the California air monitoring study were low (0.9 to 2.5 ppb).

There is some uncertainty associated with risk to nontarget plants, given the lack of guideline terrestrial plant toxicity data and the incomplete aquatic plant toxicity database. However, based on the labeled phytotoxicity of MITC (and some incidents), it is expected that at least some non-target plants off-site may be at risk from off-gassed MITC. Terrestrial plant toxicity data are needed to evaluate this risk. Levels of Concern for aquatic plants are not exceeded based on available data, but additional toxicity data are needed to complete this assessment.

Based on Tier II modeling of MITC, acute aquatic LOCs are exceeded for both aquatic invertebrates and fish in all scenarios except potatoes. Chronic aquatic LOCs are not exceeded for aquatic invertebrates at any modeled site, based on supplemental data. Chronic fish data on MITC are needed to evaluate chronic risk to fish from MITC. However, chronic exposure to MITC is expected to be low because of its high potential to volatilize from the surface water bodies. Also, the low octanol/water partition coefficient (log K_{ow} # 0.98) of MITC indicates that it is not likely to be bioconcentrated in tissues of aquatic organisms.

Although MITC is volatile, it is also highly soluble in water and its low adsorption in soil suggest that leaching to ground water may be a potential problem under flooded condition. However, under most field conditions, the potential for ground water contamination of MITC is unlikely due to its volatilization and fast degradation characteristics in soil (aerobic soil half-live, #10 days). Based on the available non-targeted monitoring data, no MITC was detected in the ground water samples within the USA. MITC can also potentially move to surface water through runoff under a possible worst-case scenario, that is, if an intense rainfall and/or continuous irrigation occurs right after metam sodium application. However, the Henry's Law Constant of MITC suggests that it will be volatilized from surface water. No monitoring data of MITC in surface water are available at the present time.

The Estimated Drinking Water Concentrations (EDWCs) for metam sodium and its metabolite MITC were calculated based on metam sodium maximum application rate of 320 lbs. a.i./Acre. The models, PRZM/EXAMS and SCIGROW were used in estimating EDWCs in surface water and groundwater, respectively. The acute concentrations in surface water are 0.03 : g/L for metam sodium and 73.22 : g/L for MITC. The cancer chronic concentrations are 2.99 : g/L for MITC and negligible (#0.001 : g/L) for metam sodium using the Florida tomato scenario. These values represent the mean value over a 30-year period. Several other scenarios (onion, strawberry, and turf) were also investigated but gave consistently lower EDWCs . The SCIGROW generated EDWCs for tomato is 0.13 : g/L for metam sodium and 0.72 : g/L for MITC, which are recommended for use for both acute and chronic exposures.

II. Introduction

Metam sodium (also known as Vapam[R], Metham Sodium, and SMDC) is a widely used fumigant on agricultural and non-agricultural sites. It is used primarily as a preplant soil sterilant to control nematodes, soil-borne diseases, insects and weeds**.** Parent metam sodium degrades rapidly to form MITC and MITC is an active ingredient of metam sodium. Potassium N-methyldithiocarbamate (PNMDC) is the potassium salt analog of metam sodium. Therefore, the ecological risk assessment of metam sodium should be applicable to metam potassium given the virtually identical physical-chemical properties and a similar use profile. Dazomet also generates MITC and may be covered in future reregistration review. However, the relative uses of dazomet as soil fumigant is considerably smaller when compared to that of metam sodium/metam potassium. EFED believes that the environmental fate and ecological risk assessment of metam sodium and metam potassium should focus on MITC. Unfortunately, the environmental fate and ecological effects data base for MITC is incomplete at this time. However, many fate properties of MITC were obtained from the open literature to prepare this reregistration review for metam sodium and its active ingredient MITC.

Metam sodium is also proposed for use as an alternative pre-plant fumigant for methyl bromide. Methyl bromide has been identified as a significant ozone depleting substance, resulting in regulatory actions being taken by the U.S. Environmental Protection Agency and by the United Nations Environment Program (Montreal Protocol). Metam sodium and its degradates do not belong to the recommended list of ozone depleting substances. Thus, metam sodium and its degradates are not a potential threat to deplete the stratospheric ozone layer.

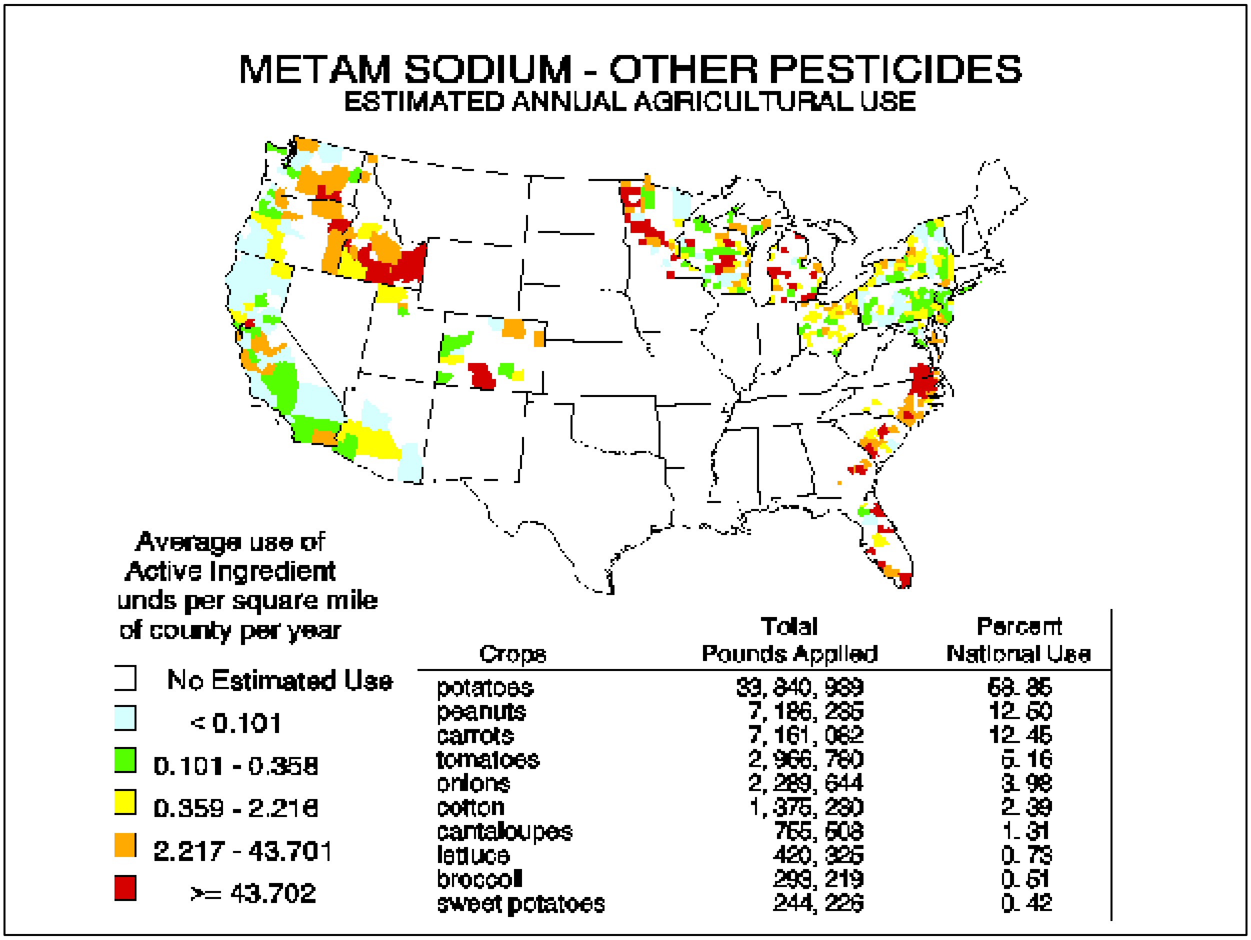
a. Pesticide Type and Mode of Action

Metam sodium (sodium-N-methyl dithiocarbamate), is a dithiocarbamate that converts readily to the isothiocyanate MITC (methyl isothiocyanate) upon application to soil. The rate of decomposition depends on the type of soil, soil moisture content and temperature. MITC is the chemical responsible for much of the toxicity to both target and non-target organisms. For example, MITC is highly reactive with the nucleophilic centers such as thiol groups in vital enzymes of nematodes, and thus appears to kill these organisms (Cremlyn, 1991).

b. Use Characterization and application methods

The LUIS report dated April 10, 2003 list the following use groups for metam sodium: terrestrial food, terrestrial feed, terrestrial non-food, aquatic non-food Industrial, agricultural soils, nonagricultural soils, greenhouse non-food, and outdoor residential. The U.S. Geological Survey (USGS) pesticide use map (Figure 1) shows regional scale patterns in use intensity within the United States. Metam sodium is used on a wide variety of crops, with major usage on potatoes, peanuts, and carrots. The USGS pesticide maps are based on state-level estimates of pesticide use rates for individual crops, which have been compiled by the National Center for Food and Agricultural Policy

(NCFAP) for 1995-1998, and on a 1997 Census of Agriculture for county crop acreage. The key limitations include: (1) state use-coefficients represent an average for the entire state and consequently do not reflect the local variability of pesticide management practices found within many states and counties, and (2) the county-level acreage are based on the 1997 Census of Agriculture and may not represent all crop acreage due to Census non-disclosure rules.



Crops	Total Pounds Applied	Percent National Use
potatoes	33,840,939	58.85
peanuts	7,186,285	12.50
carrots	7,161,062	12.45
tomatoes	2,966,760	5.16
onions	2,289,644	3.98
cotton	1,375,280	2.39
cantaloupes	755,508	1.31
lettuce	420,325	0.73
broccoli	293,219	0.51
sweet potatoes	244,226	0.42

Figure 1. Estimated uses of metam sodium by crop(Source: U.S. Geological Survey, http://ca.water.usgs.gov/pnsp/pesticide_use_maps_1997

The amount of metam sodium used in California has steadily increased in recent years, from an average of 5.5 million pounds in 1990 and 1991, to nearly 15 million pounds in 1998. Recent metam sodium usages' data from California suggest that carrots appear to have the most pounds applied overall (an estimated 28,400,000 pounds). Pistachios have the highest percent of crop treated (45%).

There are approximately 35 different products containing metam sodium in concentrations ranging from 18-42% active ingredient. The maximum application rate for food crops (with rate in lbs ai/A) is 320 lbs ai/A, with one application per crop cycle. (BEAD Screening Level Use Report, 5/5/03; BEAD Label Use Information System Report, 4/10/03).

Agricultural application methods of metam sodium include soil injection, chemigation followed by water sealing or tarping, rotary tiller, disc, power mulcher, and drenching. Post application methods like water sealing (applying sufficient water to block upward movement of the MITC gas) or tarping reduces the MITC diffusion to atmosphere from the metam sodium applied sites. Shank injection and chemigation (through sprinker or drip irrigation) are the two most frequent options when applying metam sodium.

c. Approach to Risk Assessment

Because of the rapid conversion of metam sodium to MITC, the focus of this risk assessment is MITC. There are a variety of data gaps concerning MITC for both the environmental fate and ecological effects portions of this review. Many fate properties of MITC have been obtained from open literature to prepare the current assessment. No additional environmental fate data is required at the present time.

Avian and mammalian exposure to MITC is expected to be mostly via inhalation of MITC off-gassed from treated fields. Peak and other residues were selected from a California air monitoring study.   For wild mammals, these values are compared to an acute inhalation value for MITC. Avian risk is evaluated based on the mammal assessment, since avian inhalation data are not available. A screening-level LD50/square foot analysis is also conducted for wild mammals.

Aquatic organism exposure to MITC may occur from runoff or groundwater contribution to water bodies. To evaluate aquatic organism exposure resulting from diverse cropping systems, four sites were selected: tomatoes, onions, potatoes, and turf.   Risk quotients were developed for all four sites. Data from the modeling of tomatoes (highest residues) were used for the drinking water assessment. Aquatic exposure was evaluated using EECs generated from the TIER II PRZM and EXAMS models. TIER I GENEEC models for surface water does not have the appropriate function to capture the dissipation of MITC due the volatilization. Additional input parameters DAIR (vapor phase diffusion coefficient) and ENPY (enthalpy of vaporization) were activated during the PRZM-EXAMS simulation. TIER II models were also used in calculating EDWCs. Several crop scenarios were used in estimating EECs and EDWCs using TIER II models to capture metam sodium's use pattern.

To evaluate the potential risk to aquatic organisms from the use of metam-sodium, risk quotients (RQs) are calculated from the ratio of estimated environmental concentrations (EECs) to ecotoxicity values (see Appendix I). EECs are based on the maximum application rate of metam-sodium for the proposed uses. These RQs are then compared to the levels of concern (LOC) (Appendix V) criteria used by EFED for determining potential risk to nontarget organisms and the subsequent need for possible regulatory action.

III. Integrated Environmental Risk Characterization

Metam sodium (also known as Vapam, Metham Sodium, and SMDC) is a widely used fumigant on agricultural and non-agricultural sites to control nematodes, soil-borne diseases, insects and weeds. Several key fate studies suggest that metam sodium is very unstable in soil and degrades rapidly to MITC and other minor degradates. Repeated application of metam sodium at the same site may cause microbial induced fast degradation of MITC resulting in the compromise of biocidal activities of metam sodium. MITC, the active ingredient of metam-sodium has high vapor pressure and very low affinity for sorption on soil, which suggest that volatilization will be the most important environmental route of dissipation and to a lesser extent on leaching and degradation. Photolytic degradation of MITC is the primary route of dissipation from the atmosphere.

The major concern with metam-sodium is the exposure of terrestrial and aquatic organisms to the degradate MITC. Acute Levels of Concern (LOC) are substantially exceeded for mammals, based on a preliminary LD50/square foot risk assessment screen. A refined analysis using mammal inhalation data and both monitoring and modeling data for air residues of MITC does not indicate an acute risk concern. However, ground-level monitoring data are needed to further refine this analysis. Inhalation toxicity data are not available for birds and other data are not adequate to roughly estimate such toxicity. Thus, additional avian toxicity data are needed for a complete assessment for birds. There is also a potential for exposure over a prolonged period. Birds and mammals could have territories or home ranges in the area and be exposed substantially and/or repeatedly, due to the use of metam-sodium on multiple fields over multiple days in any given geographic area. Acute aquatic LOCs are exceeded for both aquatic invertebrates and fish in all modeled scenarios except potatoes.

a. Key Fate and Transport Conclusions

Aerobic soil metabolism, photodegradation in water, and hydrolysis studies suggest that metam sodium is very unstable and degrades rapidly to MITC and other minor degradates. The environmental fate data and the residual contents in soils suggest that an adverse effect on ground water or surface water is highly unlikely from metam sodium. However, MITC, the major metabolite of metam sodium degradation in soil and water appears to be dependent on hydrolysis and microbially-mediated degradation and persist longer than metam sodium in the environment. The dissipation of MITC in aquatic and terrestrial environments appears to be predominantly dependent on volatilization and to a lesser extent on leaching and degradation. Photolytic degradation is the major dissipation route of MITC in atmosphere. Since MITC is also highly soluble in water and has low adsorption in soil, it can potentially leach into ground water and transport to surface water through runoff under a flooded condition. EFED has suggested adding a cautionary statement in the metam sodium label to avoid metam sodium application if rain is expected within 48 hours.

The aerobic soil metabolism study suggests that metam sodium degrades in soil with a half-life of 23 minutes and generates 83% of its principal gaseous degradate MITC. A similar degradation pattern and rate were observed in the photodegradation in water ($t_{1/2}$ = 28 minutes). MITC was also the major degradate formed in the photodegradation and hydrolysis studies. The hydrolysis half-lives were 2 days at pH 5 and 7, and 4.5 days at pH 9. The major degradate formed at pH 5 and 7 was MITC (18% to 60%). At pH 9, two major degradates formed, with 20 % of MITC and 16% of MCDT. The other major degradates identified in the hydrolysis study were methylamine, 1,3-dimithylthiourea (DMTU) and 1,3 dimethylurea (DMU). Methylcarbamo (dithioperoxo) thioate (MCDT) was identified in the pH 9 test solutions. The formation of methylamine was favored under acidic conditions compared to neutral or alkaline conditions. All degradates identified in the photodegradation study were also identified in the hydrolysis study except syn- and anti-N-methylthioformamide. Supplemental data from field dissipation studies also indicated that metam sodium degrades rapidly to MITC and DMU in the terrestrial environment and both of the degradates were detected only at soil depth of 0-6 inches except one time MITC at 6-9 inches depth. Methylamine was the main degradate of MITC identified in all pHs in the hydrolysis study.

The accelerated decomposition rates of MITC in previously metam sodium treated soil was investigated. Results suggest that repeated application of metam sodium induced microbial adaptation, resulting in enhanced biotransformation of MITC. Several studies confirmed that pesticidal efficacy of metam sodium was compromised due to the enhanced biodegradation MITC.

Once MITC volatilizes into the atmosphere, it dissipates rapidly due to direct photolysis (photolysis in air half-live, 29 to 39 hours). In a laboratory experiment, several MITC degradates were identified that include methyl isocyanate (MIC), methyl isocyanide, sulfur dioxide, hydrogen sulfide, carbonyl sulfur, N-methylthioformamide, and methylamine resulting from direct photolysis.

Air monitoring studies also suggest that the metam sodium application methods affect the volatility rates of MITC and consequently dictate the ambient residue of MITC and its metabolites in the air samples. Air monitoring in California shows the highest MITC concentration occurred during metam sodium application through a sprinkler irrigation system followed by water-sealing, and ranged from 78.3 to 2450 ppb at 5 meters from the field edge and from 11.7 to 1320 ppb at 150 meters from the field edge. Hydrogen sulfide gas (H_2S) was also detected at 3-76 ppb during application and 3-8 ppb 22 hours post application. These concentrations gradually decreased to non detect over the course of study (72 hours). Also, measurable MIC residues were detected in air samples ranging 0.09 to 2.5 ppb in a separate study in California. MIC is known to be very reactive and toxic to terrestrial animals.

Although MITC is volatile, it is also very soluble in water and its low adsorption in soil suggest that leaching to ground water may be a potential problem under flooded condition. However, under most field conditions, the potential for ground water contamination of MITC is unlikely due to its volatilization and fast degradation characteristics in soil (aerobic soil half-live, #10 days). Based on available non-targeted monitoring data, no MITC was detected in the ground water samples within the

USA. MITC can also potentially move to surface water through runoff under an intense rainfall and/or continuous irrigation occurs right after metam sodium application. However, the Henry's Law Constant of 1.79 x 10^{-4} atm-m^3/mol for MITC suggests that it will be volatilized quickly from surface water.

b. Ecological Risk

EFED's major concern with metam-sodium is the transformation to MITC which is highly volatile and can off-gas from treated fields and potentially expose a range of nontarget terrestrial organisms in its path. MITC also has the potential to reach surface water bodies.

EFED used the screening-level LD50/ft^2 method as a preliminary step to assess risks of the pesticide to mammals. This method has most frequently been applied to pesticide application scenarios involving granular formulations, seed treatments, and baits. The method has not been generally applied to situations involving highly volatile compounds, but remains the Agency's most appropriate index for this type of use. This LD50/ft^2 method is an index that does not systematically account for exposures from each potential route, but considers the overall potential for adverse effects given a bioavailable amount of pesticide conservatively related to the mass applied per unit area at the treatment site. See the uncertainty discussion in Section VII. Three mammal body weights are assessed: 15g, 35g, and 1000g. The resulting risk quotients for these three sizes of mammals are 1,897, 813, and 28, respectively (see Section VII). These far exceed the acute risk LOC of 0.5, as well as the acute restricted use LOC of 0.2 and the acute endangered species LOC of 0.1. Thus, this preliminary screen indicates a potential for concern for risk to wild mammals, and a refined analysis based specifically on inhalation exposure is described below.

Owing to the limitations of the the LD50/ft^2 method for highly volatile compounds and the recognized high potential volatility of the pesticide once broken down to MITC, EFED investigated the potential for inhalation to be a toxicologically significant route of exposure to birds and mammals within the use area. While data on inhalation toxicity are available for mammals (from HED), inhalation toxicity data are not available for birds.

Available monitoring data for MITC from California (Wofford et al., 1993) indicate that the highest MITC concentrations occur primarily during pesticide application and immediately following watering-in referred to as soil sealing periods. Concentration during application ranged from 78.3 to 2450 ppb (0.002342 to 0.007327 mg/L) at 5 meters from the field edge and 11.7 to 1320 ppb (0.000035 to 0.003948 mg/L) at 150 meters from the field edge. A comparison of these air concentrations with available mammalian acute inhalation effects data (MRID 42365605) is as follows (Table 1).

Table 1. Comparison of Measured Air Concentrations with Acute Mammalian Inhalation Toxicity Endpoint

Air concentration (mg/L)	Acute Mammal LC50 (mg/L)	Ratio Exposure/Effects (RQ)
5 meters off field		

Table 1. Comparison of Measured Air Concentrations with Acute Mammalian Inhalation Toxicity Endpoint

0.002342	0.54	0.004
0.007327	0.54	0.014
150 meters off field		
0.000035	0.54	0.00006
0.003948	0.54	0.007

Monitoring data for a limited number of application sites is not necessarily predictive of all site conditions where the pesticide may be used. Also, most monitoring data is for samples collected at least 0.5 m above the ground, often higher. This height is above the level for many ground-dwelling mammals and ground-feeding birds. It is reasonable to assume a gradient of concentrations at the treatment site, with higher concentrations of methyl bromide occurring closer to the ground. This would be especially applicable to those times that a tarp is not used (and animals would be more likely to be on the soil surface of the treated field). Thus, modeling has been used to attempt to estimate residues closer to the field and ground.

The ISC model provides more flexibility compared to the monitoring data (i.e., results are more easily extrapolated) and generally allows the Agency to consider a much broader set of circumstances in its assessments. Nevertheless, since EFED is relying on off-site monitoring data, the model calculation does not specifically produce on-field, ground surface level air residues. Because of uncertainties associated with both monitoring and modeling, the Agency has calculated risk estimates based on both, for comparison.

The ISC model estimated MITC concentrations were used in calculating the concentrations on the edge of the field from a field application of metam sodium. The highest air concentration of 0.0084 mg/L was estimated immediately adjacent to the field, using sprinkler irrigation and a standard seal. With an acute mammal LC50 of 0.54 mg/L, the risk quotient for this modeled concentration is 0.02 (0.0084/0.54).

The Agency has not established level of concern (LOC) thresholds expressly for the interpretation of RQs calculated for inhalation exposure risks. However, if the existing LOC values for acute mammalian wildlife risk were used to evaluated such RQs, the above analysis based on monitoring data (highest risk quotient of 0.014) and modeling (risk quotient of 0.02) would suggest that neither the acute endangered species LOC (0.1), the acute restricted use LOC (0.2), nor the acute risk LOC (0.5) would be exceeded. The uncertainty level in these analyses can be reduced with submission of ground-level monitoring data (e.g., 3 inches) both within-field and edge-of-field, for maximum application rates and sprinkler irrigation and standard seal application methods.

The above assessment is limited to acute effects and exposure windows. Wild mammals may have home ranges in the treatment area and may be exposed continuously and/or repeatedly as the result of metam sodium use on multiple fields over multiple days in any geographic area. Given that the rat 28-day inhalation NOAEL for MITC is 20 μg/L, lower than the acute inhalation endpoint, EFED investigated the potential for a concern for chronic exposure and effects. Wofford et al., 1993 reported that air samples were below a detection limit of 2 ppb (0.000006 mg/L) by 72 hours after application, suggesting that long term air concentrations would be well below the chronic inhalation NOAEL for mammals, based on the treatment of a single field. However, multiple fields may be treated in an area over a number of days. Therefore, there still exists a potential that mammals within an area of multiple treated fields may be exposed to toxicologically significant MITC emissions over prolonged periods.

The above analysis is based on mammalian toxicity data for the inhalation route. A similar analysis could be performed for birds, if the necessary data were available. However, no inhalation toxicity data for MITC are available for birds. If acute toxicity by the oral route were available for both mammals and birds, an evaluation of the relative sensitivity via the oral route might be extrapolated to the inhalation route to estimate an acute inhalation endpoint for birds. However, no acute oral toxicity data for MITC are available for birds. Therefore, EFED is limited to an assumption of equivalent sensitivity between birds and mammals for MITC exposure through inhalation. EFED feels that such an extrapolation may not be protective, given higher respiration rates for birds versus mammals, and physiological differences in the avian lung that would tend to favor higher diffusion rates across the lung membrane when compared to mammals. Therefore, inhalation analyses that suggest a potential for adverse effects in mammals would also suggest potential risks to birds via the inhalation route, but analyses not indicating risk to wild mammals would not necessarily be true for birds also.

Although birds are mobile and some may only have a very brief exposure flying by, others may have territories or nests in the area and be exposed more substantially and/or repeatedly. Repeat exposures can occur since metam-sodium may be applied to different fields in a given geographic area on different days. The uncertainty level can be reduced with this screening-level analysis by submission of avian toxicity data, in addition to the above-cited ground-level monitoring data. HED has indicated in their draft HIARC report that a chronic mammal inhalation study (developmental neurotoxicity study) with MITC is needed. A chronic avian inhalation study will enable EFED to address chronic exposure to birds as well.

Based on the labeled phytotoxicity of MITC on the treated fields, it is expected that non-target plants off-site may also be a risk from off-gassed MITC. Terrestrial plant guideline toxicity data are needed to evaluate this risk. LOCs for aquatic plants are not exceeded based on available data, but additional toxicity data are needed to complete this assessment.

EECs to determine the acute and chronic risk to aquatic organisms from MITC were estimated using PRZM/EXAMS models with selected scenarios (onion, turf, tomatoes, potatoes), involving chemigation, to represent the numerous crops for which metam sodium is registered for use. Although the same application rate of 320 lbs of metam sodium per acre was used for all four crop scenarios, the MITC exposure estimated resulted in different risk potentials. Based on this exposure assessment, 1) tomatoes (with higher estimated residues than the other three sites) exceeded the acute endangered species, acute restricted use, and acute risk LOCs, 2) onions and turf exceeded the acute endangered species and acute restricted use levels of concern and 3) the potato exposure scenario did not exceed any LOC. The LOCs exceeded for tomatoes, onions, and turf are for both fish and aquatic invertebrates. Exposure modeling indicates that MITC residues would likely exceed acute risk LOCs following unusually high rain events. Chronic aquatic LOCs are not exceeded for aquatic invertebrates at any modeled site, but the

analysis is based on supplemental data. Chronic fish data on MITC are needed to evaluate chronic risk to fish from MITC.

A tank car spill incident in 1991 (not representative of agricultural applications) showed clearly that metam-sodium has the ability to kill large numbers of aquatic organisms if the chemical gets into water in large quantities. Also, fish farm incidents show the potential for off-gassed MITC (from agricultural application of metam-sodium) to be inadvertently drawn into man-made aeration systems, resulting in possible fish mortality.

In addition to the pre-plant fumigation uses of metam sodium, there is a use in sanitary sewers to control tree roots. There is reportedly (Martyn, P., 2004) a contaminant (NDMA, n-nitrosodimethylamine) in the product for which there is a National Recommended Water Quality Criteria of 0.00069 : g/L (current/potential drinking water) and 3.0 : g/L (no potential for drinking water). OPP will continue to work with the Office of Water and other stakeholders to investigate the potential NDMA contamination of water resources.

A very recent study (Haendel, M, et. al. 2004) examines the developmental toxicity of both metam sodium and MITC in the zebrafish (*Danio rerio*). It reports "severely twisted" notochords in the developing fish. The LOAEL for both notochord defects and decreased hatching rate is reported to be 26 ppb for metam sodium (where 25% of the fish had malformations) and 29 ppb for MITC. A 48 hour post fertilization (hpf) LC50 is reported to be 248 ppb and 137 ppb for MITC. The MITC concentration at which malformations are reported is below the EFED peak aquatic EEC of 35.11 ppb for tomatoes. While not an OPP guideline study, this study raises serious concerns about the developmental toxicity of metam sodium and MITC. It adds further weight to the identified need for fish early life-stage testing of MITC under USEPA test guidelines.

c. Endangered Species

The Agency's Levels of Concern (LOC) for endangered and threatened fish and aquatic invertebrates are exceeded for three of four modeled use patterns, based on MITC concentrations. Similar risks may also be associated with the many additional, non-modeled use sites. The current analysis does not indicate a risk to endangered mammals from inhalation, based on existing air monitoring and modeling, but additional ground-level monitoring data can refine this analysis. Birds may be more sensitive than mammals, but additional toxicity data are needed for analysis. It is also expected that any insects or other terrestrial invertebrates exposed to MITC would be adversely affected. At present, metam-sodium is labeled in some cases for all crops. If the registrants can narrow the labels to specific crops, a list of endangered/threatened species associated with these specific crops can be provided. Although endangered species LOCs are exceeded using freshwater invertebrate data, the oyster (marine/estuarine) is very likely to be more representative of endangered/threatened freshwater molluscs than is the freshwater daphnid. This is a data gap for MITC.

The Agency has developed the Endangered Species Protection Program to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that address these impacts. The Endangered Species Act requires federal agencies to ensure that their actions are not likely to jeopardize listed species or adversely modify designated critical habitat. To analyze the potential of registered pesticide uses to affect any particular species, EPA puts basic toxicity and exposure data developed for REDs into context for individual listed species and their locations by evaluating important ecological parameters, pesticide use information, the geographic relationship between specific pesticide uses and species locations, and biological requirements and behavioral aspects of the particular species. This analysis will take into consideration any regulatory changes recommended in this RED that are being implemented at this time. A determination that there is a likelihood of potential impact to a listed species may result in limitations on use of the pesticide, other measures to mitigate any potential impact, or consultations with the Fish and Wildlife Service and/or the National Marine Fisheries Service as necessary.

As part of the interim program, the Agency has developed County Specific Pamphlets that articulate many of the specific measures outlined in the Biological Opinions issued to date. The Pamphlets are available for voluntary use by pesticide applicators on EPA's website at www.epa.gov/espp. A final Endangered Species Protection Program, which may be altered from the interim program, was proposed for public comment in the Federal Register December 2, 2002.

d) Endocrine Disruption

Metam-sodium/MITC do not appear to present a specific endocrine disruption risk at present. Nevertheless, EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) *"may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen, or other such endocrine effects as the Administrator may designate."* Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was a scientific basis for including, as part of the program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA authority, and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority, to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP). When the appropriate screening and/or testing protocols being considered under the Agency's EDSP have been developed, metam-sodium and MITC may be subjected to additional screening and/or testing to better characterize effects related to endocrine disruption.

IV. ENVIRONMENTAL FATE ASSESSMENT

(A) Physicochemical Properties

Selected physical and chemical properties of technical grade active ingredient (TGAI) of metam sodium (metam sodium dihydrate; crystalline) are listed in Table 1. Metam sodium is stable in its dry, crystalline and concentrated aqueous solution. Metam sodium is non-volatile and readily soluble (722 g/L @ 20^{0}C) in water and degrades very rapidly to MITC in soil. MITC has high vapor pressure (19 mm Hg at 20^{0}C) and the Henry's Law Constant of 1.79 x 10^{-4} atm-m^3/mol, which suggests that it will be volatilized from metam sodium applied fields. It has a distinct pungent horse-radish like odor. Selected physical and chemical properties of MITC are also listed in Table 2.

Table 2. Physico-chemical and environmental fate properties of Metam Sodium and Methyl Isothiocyanate (MITC)

Parameters	Values & Units	Sources
Chemical Name: Sodium N-methyldithiocarbamate, Methyldithiocarbamic acid sodium salt **Common Name: Metam Sodium, Metam, Metham, Metham Sodium**		
Chemical Abstract Number (CAS)	137-42-8	Product Chemistry
Molecular Formula	$C_2H_4NNaS_2$	Product Chemistry
Molecular Weight	129.2 g Mole^{-1}	MRID 459194-01
Vapor Pressure 25^{o}C	Non volatile	Agrochemical Handbook
Water Solubility @ pH 7.0 and 20^{o}C	722g L^{-1}	Agrochemical Handbook
Chemical Name: Methyl isothiocyanate **Common Name: Methyl isothiocyanate, MITC, MIT, Methyl Mustard Oil**		
Chemical Abstract Number (CAS)	556-61-6	Product Chemistry
Molecular Formula	C_2H_3NS	Product Chemistry
Molecular Weight	73.12g Mole^{-1}	Product Chemistry
Vapor Pressure 25^{o}C	19 mm Hg	Product Chemistry
Water Solubility @ pH 7.0 and 25^{o}C	7.6 g L^{-1}	Product Chemistry
Henry's Law Constant	1.79 x10^{-4} (atm-m^3/mol)	Estimated

(B) Fate and Transport in soil and water

Metam sodium is highly unstable in the environment, breaking down rapidly to form MITC and other degradates. Metam sodium and MITC are both highly soluble in water and are weakly retained by soil. The dissipation of MITC in aquatic and terrestrial environments appears to be predominantly dependent on volatilization and to a lesser extent on leaching and degradation. The high vapor pressure and the estimated Henry's Law Constant of 1.79 x 10^{-4} atm-m^3/mol suggests that MITC will volatilize readily. Once it volatilized, MITC degrades rapidly into hydrogen sulfide (H_2S) and other metabolites in the atmosphere due to photochemical reaction. Selected environmental fate properties of metam sodium and MITC are listed in Table 3. Chemical structures of metam sodium and it's selected degrades are presented in Appendix II.

Table 3. Environmental fate properties of Metam Sodium and Methyl isothiocyanate (MITC)

Parameters	Values & Units	Sources
Metam Sodium		
Hydrolysis Half-Life (pH 5)	2.0 Days	MRID 416311-01
Hydrolysis Half-Life (pH 7)	2.0 Days	MRID 416311-01
Hydrolysis Half-Life (pH 9)	4.5 Days	MRID 416311-01
Aerobic Soil Metabolism ($t_{½}$)	23 Minutes	MRID 401985-02
Photodegradation in water($t_{½}$)	28 Minutes	MRID 415177-01
Photodegradation in soil($t_{½}$)	63 Minutes	MRID 429787-01
Octanol/Water partition coefficient (log K_{ow})	0.46	EPISUITE*
Soil Water Partition Coefficient (K_{oc})	4.04 L Kg^{-1}	EPISUITE*
Methyl isothiocyanate (MITC)		
Hydrolysis Half-Life (pH 5)	3.5 day	MRID 00158162
Hydrolysis Half-Life (pH 7)	20.4 day	MRID 00158162
Hydrolysis Half-Life (pH 9)	4.6 day	MRID 00158162
Aerobic Soil Metabolism ($t_{½}$)	6.01 Days (mean value)	Gerstl et at., 1977
Anaerobic aquatic metabolism($t_{½}$)	21 day	MRID 435965-01
Photodegradation in water($t_{½}$)	51.6 Day	CDPR, 2002
Photodegradation in Air($t_{½}$)	1.21 to 1.60 Days	Geddes, et al., 1995
Octanol/Water partition coefficient (log K_{ow})	0.98	Product Chemistry
Soil Water Partition Coefficient (K_d)	0.26 L Kg^{-1} (Mean K_d)	Gerstl et at., 1977

* = The EPI (Estimation Program Interface) SuiteTM is a Windows® based suite of physical/chemical property and environmental fate estimation models developed by the EPA's Office of Pollution Prevention Toxics and Syracuse Research Corporation SRC. http://www.epa.gov/opptintr/exposure/docs/updates_episuite_v3.11.htm

Degradation and Metabolism

Hydrolysis

The hydrolysis of metam sodium half-lives were 2 days at pH 5 and 7, and 4.5 days at pH 9 (Table 2). In the hydrolysis study, the degradates identified in all test solutions were MITC, methylamine, 1,3-dimithylthiourea (DMTU) and 1,3 dimethylurea (DMU). Methylcarbamo (dithioperoxo) thioate

(MCDT) was identified in the pH 9 test solutions. The major degradate formed at pH 5 and 7 was MITC (18% to 60% respectively). At pH 9, two major degradates formed, with 20 % of MITC and 16% of MCDT. The formation of methylamine was favored under acidic conditions compared to neutral or alkaline conditions. MITC hydrolyzes with half-lives of 3.5 days at pH 5, 20.4 days at pH 7, and 4.6 days at pH 9 (MRID 00158162). Methylamine was the main degrade of MITC identified in all pHs. One other degradate, N,N-dimethylthiourea was isolated in the pH 9 only, comprised a maximum 22.1% of the recovered at 13.04 days posttreatment.

Photolysis

The photodegradation half-life of metam sodium in aqueous solution was 28 minutes (Table 2). Except for syn- and anti-N-methylthioformamide, the degradates identified in the photodegradation study were also identified in the hydrolysis study. Syn- and anti- N-methylthioformamide were at a maximum concentration of 22.3% by the end of the study interval; methylamine increased to 17.5%, MITC increased to 16%, and MCDT increased to 14.1%. The placement of metam sodium below the soil surface (except sprinkler irrigation), and rapid degradation of metam sodium in soil to volatile MITC suggest that photolysis on soil would be a negligible route of degradation.

Aerobic Soil Metabolism

In an aerobic soil metabolism study (MRID 401985-02), metam sodium degrades in soil with a half-life of 23 minutes (Table 2). The majority of the residues had been volatilized: 83% of the applied as MITC; 0.2% as other organic volatiles, and 0.9% as CO_2. The major nonvolatile degradate was DMU at a maximum of 0.45 ppm at 3 and 7 days. The degradation rates of MITC in soils have been reported in number of studies (Ashley et al., 1963, Smelt and Leistra, 1974, Gerstl et al, 1977, Boisteen et al., 1989). These studies generally found that MITC degradation in soil was dominated by microbial processes and followed first-order degradation kinetics. Gerstl et al. (1977) demonstrated that metam sodium breakdown to MITC was rapid and generally less than 30 minutes at moisture contents below saturation. They also reported that MITC was found to persist longer than metam sodium, with half-lives ranging from 3.3 to 9.9 days depending on soil composition. Since MITC is a volatile compound, very little information is available on the metabolites of MITC degradation in soil. Smelt et al. (1989) investigated the accelerated decomposition rates of MITC in previously metam sodium treated soil and suggested that repeated application of metam sodium induced microbial adaptation, resulting in enhanced biotransformation of MITC. Dungan and Yates (2003) reported that the microorganisms responsible for enhanced degradation of MITC specifically target the isothiocyanate functional group. Several studies (Dungan and Yates, 2003; Warton and Metthiessen, 2000; Boesten et al., 1991) attributed that pesticidal efficacy of metam sodium was compromised due to the enhanced biodegradation.

Aerobic Biotransformation of in Water-Sediment System

Potassium N-methyldithiocarbamate (PNMDC) is the potassium salt analog of metam sodium. PMNDC provided useful supplemental information about the end point of its major trasfomation product, MITC. The aerobic biotransformation of PNMDC was studied (MRID 42710201) in pond or river water/sediment system from Pennsylvania, USA. The calculated half-life of PNMDC in aerobic water/sediment entire system was 20 minutes. The major transformation products detected in the water/sediment system were MITC (methyl isocyanate, and DMTD (1,1'-Dimethylthiuramdisulfide, a transient product), with maximum concentrations of 74.4 and 21.5% of the applied amount respectively.

Anaerobic Biotransformation in Water-Sediment System

An anaerobic biotransformation in water-sediment system was performed for dazomet and its degradate MITC (MRID 435965-01). MITC is the common metabolite for both dazomet and metam sodium. Radiolabelled MITC had a half-life of 21 days in non-sterile, anaerobic soil-water system under a static incubation system. The dissipation of MITC appears to be dependent on primarily volatilization and to a lesser extent on degradation.

Adsorption/Desorption

Soil adsorption coefficient (K_{oc}) of metam sodium cannot be estimated from the batch equilibrium study (MRID 152844). Due to the rapid degradation of metam sodium to MITC, it is unlikely that an equilibrium of metam sodium in the batch equilibrium will be reached. The K_{oc} of metam sodium was estimated using the EPA's computer model PCKOCWIN v1.66 of EPISUITE. EPI's K_{oc} estimations are based on the Sabljic molecular connectivity method. The estimated K_{oc} of metam sodium is 4.04 L/Kg. Metam sodium's high water solubility (722g/L) and low K_{oc} of 4.04 ml/g suggest its high mobility in the environment. Gerstl et al. (1977) investigated the adsorption behavior of MITC in four soils with variable amounts of clay and organic matter contents. The results presented in Table 4 show that soils high in clay and organic matter adsorb more MITC than the soils with little and no clay and organic matter.

Table 4. Estimation of Koc‡

Soil	Organic matter (%)	Organic Carbon (%)	Clay (%)	Kd (mL/g)	Koc (mL/g)
Mivtachim	0.45	0.26	3	0.012	4.6
Gilat	0.5	29	20	0.045	15.52
Golan	4.98	2.89	68.5	0.41	14.19
Har Baroan	4.1	2.38	65.3	0.57	23.97
Median Value					14.86

‡ Gerstl et al., 1977

The high solubility and low soil absorption of metam sodium and MITC can result in movement of these chemicals downward to groundwater with water infiltration under an intense rainfall or continuous irrigation right after metam sodium application. A supplemental leaching study (MRID

470103-02) conducted for the metam sodium Data Call-In (DCI) demonstrated that MITC is very mobile in soil.

Terrestrial Field Dissipation

The two supplemental terrestrial field dissipation studies (MRID 415144-02 and 417986-01) were conducted in Leland, Mississippi and Visalia, California, applying metam sodium to bare fallow soil at a rate of 100 gallons of formulated material (32.7% a.i) per acre through chemigation with an overhead sprinkler system. Results suggest that metam sodium degrades rapidly to MITC and DMU in the terrestrial environment and both of the degradates were detected only at soil depth of 0-6 inches except one time MITC at 6-9 inches depth. In Leland, Mississippi, the MITC concentration was 41-51ppm at 0-6" depth immediately after post treatment and decreased to 0.2-0.11 ppm by day 4. The maximum concentrations of DMU were 0.21-1.07 ppm observed at 4 hours to 4 days post treatment. In Vasilia, California, the maximum MITC concentration was 12-22 ppm at 0-6" depth immediately after treatment and decreased to 0.07-0.16 ppm by day 7. The maximum concentrations of DMU were 0.09-0.29 ppm observed at 4 hours to 7 days post treatment. No MITC (<0.02 ppm) and DMU (<0.02 ppm) were detected at 7-14 days and 32-91 days respectively in post treatment soil sampling in both sites. The calculated half-lives of MITC and DMU were less than 24 hours and 7 days respectively. Several other degradates of metam sodium identified in the laboratory studies were not monitored in these field dissipation studies. However, aerobic soil metabolism study suggests that only 4% constitute nonvolatile metabolites.

Field Volatility

A field volatility study (MRID 426599-01) was conducted to determine the potential levels of off-site movement of MITC during field application of metam sodium. Metam sodium was applied to bare ground at the maximum label rate of 100 gallons per acre (309 a.i. lbs/A) for four hour period. Movement of MITC was measured in four hours intervals at 5, 25, 125, and 500 meters downwind from the application area during field application and for 48 hours after the application. Maximum volatilization occurred in the period up to about eight hours after application. The maximum field volatility of MITC was measured 22g/ha/8 hours day, and decreased to < 0.4 g/ha/8-hours day at the end of 48-hours monitoring period.

(C) Fate and Transport in atmosphere

MITC is the major volatile transformation product of metam sodium. Once MITC is volatilized into the atmosphere, it undergoes direct photolysis. Geddes et al. (1995) estimated the half-live of MITC in atmosphere ranged from 29 to 39 hours. Alvarez and Moore (1994) calculated a photolysis half-life of 39 hours for noontime condition of mid summer at 40° N latitude. Several metabolites were identified that included methyl isocyanate (MIC), methyl isocyanide, sulfur dioxide, hydrogen sulfide, carbonyl sulfur, N-methylthioformamide, and methylamine (Geddes et al.,1995). They also reported that 7% of MITC can potentially degrade to MIC. MIC is known to be very reactive and can be acutely toxic to terrestrial animals. In California, ambient air concentrations of MIC were monitored following a ground injection of metam sodium and reported concentrations were 0.09 to 2.5 ppb (0.2-5.8 $\mu g/m^3$) in the first 72 hours (ARB, 1997).

(D) Monitoring Data (Air)

Several air monitoring studies have been conducted in California to determine the concentrations of MITC in air adjacent to the metam sodium applied sites associated with specific application methods. Wofford et al., 1993 conducted a study in August 1993 in Kern County, California to measure the concentrations of MITC in air associated with a sprinkler application of metam sodium. Sixty percent of air samples had detectable MITC residues. The highest MITC concentration occurred primarily during the application and immediatlely following the watering-in referred as soil sealing periods. Concentration during application ranged from 78.3 to 2450 ppb at 5 meters from the field edge and 11.7 to 1320 ppb at 150 meters from the field edge. Hydrogen sulfide gas (H_2S) was also detected at 3-76 ppb during application and 3-8 ppb 22 hours post application. These concentrations gradually decreased to non detect over the course of the study (72 hours). No carbon disulfide (CS_2) was detected above the detection limit of 4 ppb. A separate air monitoring study was conducted in Kern County, California to measure the MITC and MIC residue in air associated with soil injected application of metam sodium (ARB, 1997). Measurable MITC residues were detected in all samples ranging from 0.21 to 84 ppb (0.24 to 250 $\mu g/m^3$). MIC concentrations were ranging from 0.09 to 2.5 ppb (0.2-5.8 $\mu g/m^3$). These studies suggest that the metam sodium application methods affect the volatility rates of MITC and consequently dictate the ambient residue of MITC in the air samples.

Several studies were performed to determine the concentrations of MITC in the ambient air samples. These air sampling are not necessarily coincided with application of metam sodium in the area. However, these studies were carried out in high use areas of California. MITC concentration measured in the ambient air were considerably lower than the concentrations monitored in the application site. Seiber et al., (1999) reported the MITC concentrations in ambient air samples from indoor (residential) and outdoor near Kern County, California. This study was conducted during the Summer time of 1997 and the Winter time of 1998. Approximately 75 percent of the samples in Summer of 1997 and 67 percent of air samples of winter 1998 collected had detectable concentrations of MITC. The reported MITC concentrations in the air samples collected during the Summer of 1997 ranged from " not detected" to 6.02 ppb for indoor air samples and "not detected" to 10.41 ppb for the outdoor air samples. The MITC concentration for the Winter of 1998 air samples for both indoor and outdoor were very similar and had MITC concentrations less than 1.36 ppb. It was concluded that the proximity to the treated fields, timing of the metam sodium application, and prevailing wind directions seemed to be contributing factors with respect to detectable MITC residue in the ambient air samples. Another air monitoring study was conducted at five locations in Lompoc, California. The concentrations of MITC and other pesticides in ambient air samples were monitored from August 31 through September, 13, 1998 within the Lompoc City limits adjacent to the agricultural fields. The concentrations of MITC ranged from "not detected" to 0.34 ppb (1.0 $\mu g/m^3$).

(E) Estimated MITC Concentrations in Air

The Industrial Source Complex (ISC) air dispersion model developed by USEPA (USEPA, 1995) was used in estimating atmospheric concentrations of MITC. The ISC has been used successfully to simulate MITC levels in air following the fumigation of warehouses and agricultural fields located in California (Barry et al. 1997). A large number of air monitoring studies were conducted in California and evaluated for the emission of MITC from treated fields. Based on the air monitoring data of California, CDPR has estimated flux rates under various MITC application methods from fumigated fields.

The modeling approaches used by the Agency were based on 24 hours exposure intervals (i.e., 24 hours time-weighted average of monitored air concentration of MITC). Field sizes includes 1-, 5-, 10-, 20-, and 40 acre squares to represent a cross section of the fields that might be fumigated for agriculture use. ISC was used in estimating air concentration using field emission ratio (ratio of the flux rate to the application rate), various sized fields, methods of MITC placement, and different meteorological conditions. The basic approaches to estimate air concentrations using ISC model are outlined in the Health Effects Division's *Draft Standard Operating Procedures (SOPs) for Estimating Bystander Risk from Inhalation Exposure to Soil Fumigant (USEPA,2003).* ISC estimated downwind air concentrations using hourly meteorological conditions that include the wind speed and atmospheric stability.

In this assessment, one set of computations was completed using ISC model at varying acreage and atmospheric conditions. The lower the wind speed and more stable the atmospheric environment, the higher the air concentrations were observed near the treated areas. The outputs were then scaled to appropriate emission ratios and application rates. Assuming stable weather condition, Table 5 reflects a wide variety of emission ratios and the concentrations of MITC in air, which also represent differences in such factors as application methods, depth of application, use and type of tarping, field size, and soil characteristics. A maximum concentration of 0. 008 mg/L (8404 : g/m^3) was estimated using 320 lbs/A application rate, 40 acres field size and 0.23 emission ratio under selected California Department of Pesticide Regulation's (CDPR) application Permit Conditions. Permit conditions and detailed input assumptions and model results were described in the *HED's Draft Chapter on Non-Occupational Risks Associated with MITC (USEPA, 2004).* Appendix VI depicts the concentrations of MITC at various distances for the different application methods, sealing methods, and meteorological conditions for acute exposure (24 hours).

V. WATER RESOURCE ASSESSMENT

Metam sodium and its major degradate MITC are readily soluble in water and have low adsorption into soil, thus these compounds can potentially leach into shallow ground water and leaky aquifers. A supplemental leaching study conducted for the metam sodium demonstrated that MITC is very mobile in soil. MITC can also potentially move to surface water through runoff under a possible worst-case scenario, that is, if an intense rainfall and/or continuos irrigation occurs right after metam sodium application. However, the Henry's Law Constant of 1.79×10^{-4} atm-m^3/mol for MITC suggests that it will be volatilized from surface water. TIER I GENEEC and FIRST models for surface water do not have the appropriate function to capture the dissipation of MITC due to volatilization. Therefore, coupled TIER II PRZM/EXAMS was used to estimate the environmental concentrations for drinking water and ecological risk assessment. Several crop scenarios were used in estimating EECs and EDWCs using TIER II models to capture metam sodium's use pattern. Additional input parameters DAIR (vapor phase diffusion coefficient) and ENPY (enthalpy of vaporization) were activated during the PRZM-EXAMS simulation.

The important output parameters for the modeling exercises are the peak, 96 hour, 21 day, 60 day, 90 day and yearly MITC levels estimated in the model reservoir and pond. The higher EECs were observed for all the scenarios as compared to Idaho potato scenarios. The large variation of MITC levels estimated in surface waters can be traced to chemical loadings into either the environmental pond or index reservoir from the PRZM output. Since the chemical input parameters are identical in each PRZM run, the different outputs are entirely dependent upon the different soil parameters used in the corresponding crop scenarios during the PRZM portion of the modeling exercise, as well as the scenario-specific meteorological data. A much higher percentage of pesticide was dissipated in the environment and /or leached below the root zone level for the Idaho potato scenario as compared to other scenarios due to a number of factors such as slope, soil type, moisture content, and the runoff curve numbers used for the different fields. This resulted in runoff and erosion flux vectors for Florida tomato, California onion, and Pennsylvania turf scenarios that were considerably higher than those estimated from the Idaho potato scenario. As a consequence, the MITC loadings into the EXAMS model environment were much higher, resulting in the larger EECs. Also, there are few infrequent occurrences of very high EECs that were observed in these scenarios, which can be traced to relate with high rainfall events.

The maximum application rate and relevant environmental fate parameters for metam sodium and MITC were used in the two screening models PRZM/EXAMS and SCIGROW for metam sodium concentrations in surface water and groundwater, respectively. The application rate of MITC was calculated using the following approach .

Stoichiometry of MITC formation from Metam sodium

$$C_5H_{10}N_2S_2 \longrightarrow C_2H_3NS \quad + \quad \text{other products}$$

(Metam Sodium; MW = 129.2) **(MITC; MW = 73.12)**

From the equation shown above, one mole or 129.2 mass unit of metam sodium degrades to produce one mole or 73.12 mass units of MITC. Thus, the mass conversion ratio or molecular weight (MW) ratio of MITC to metam sodium is 0.566. The hydrolysis study suggests that the maximum conversion rate of metam sodium to MITC was 83%. Therefore, the maximum application rate of MITC would be (0.83)(0.566)(320.0) = 150.3 lbs/Acre at 320lbs/Acre application rate for metam sodium.

(a) Estimated Environment Concentration for Drinking Water Assessment

The Estimated Drinking Water Concentrations (EDWCs) for metam sodium and its metabolite MITC were calculated based on a maximum application rate of 320 lbs. a.i./Acre. The models, PRZM/EXAMS and SCIGROW were used in estimating EDWCs in surface water and groundwater, respectively. The acute concentrations in surface water are 0.03 : g/L for metam sodium and 73.22 : g/L for MITC. The cancer chronic concentrations are 2.99 : g/L for MITC and negligible (#0.001 : g/L) for metam sodium using the Florida tomato scenario. These values represent the mean value over a 30-year period. Several other scenarios (onion, strawberry, and turf) were also calculated. The worst case scenario appears to be Florida tomatoes. The SCIGROW generated EDWCs for tomato is 0.13 : g/L for metam sodium and 0.72 : g/L for MITC, which are recommended to use for both acute and chronic exposuresers. The results are presented in Table 6. The SCIGROW generated EDWC for groundwater did not account for the volatilization of MITC, hence, this value may be more conservative than it would be for a non-volatile chemical. The submitted memorandum to Health Effects Division (HED) describing the model, inputs parameters and outputs for EDWC can be found in Appendix III.

Table 6. Estimated Drinking Water Concentrations (EDWC's) in surface water and

Chemical	Surface Water (µg/L)			Groundwater (µg/L)
	Acute	Non-cancer chronic	cancer chronic	
Florida Tomato				
Metam Sodium	0.03	0	0	0.13*
MITC	73.22	0.53	2.99	0.72*

* Recommended EDWCs values for acute and chronic for groundwater

(b) Estimated Environment Concentration for Ecological Risk Assessment

Estimated Environmental Concentrations (EECs) were estimated using selected scenarios and Tier II PRZM/EXAMS models to determine the acute and chronic risks to aquatic organisms. The maximum application rate (320 a.i. lbs/A) for these crops and the relevant environmental fate parameters for metam sodium and MITC were used in PRZM/EXAMS screening models. The EECs to be used for ecological risk assessments are presented in Table 7. A complete discussion of these models and the associated input parameters and output for each scenario is presented in Appendix IV.

Table 7: Estimated Environmental Concentrations (EECs) in surface water for selected crops scenarios

Chemical (Application rate, frequency)	Acute: Peak EEC (μg/L)	Chronic: 21-day Average EEC (μg/L)	Chronic: 60-day Average EEC (μg/L)
California Onion			
Metam Sodium (320 lbs ai/A , 1X Per Season)	0	0	0
MITC (150.3 lbs ai/A , 1X Per Season)	10.39	2.41	0.86
Florida Tomato			
Metam Sodium (320 lbs ai/A , 1X Per Season)	0.02	0	0
MITC (150.3 lbs ai/A , 1X Per Season)	35.11	5.47	1.93
Idaho Potato			
Metam Sodium (320 lbs ai/A , 1X Per Season)	0	0	0
MITC (150.3 lbs ai/A , 1X Per Season)	1.54	0.34	0.12
Pennsylvania Turf			
Metam Sodium (320 lbs ai/A , 1X Per Season)	0	0	0
MITC (150.3 lbs ai/A , 1X Per Season)	7.98	1.75	0.62

Monitoring Data (Surface water and Groundwater)

Several water monitoring studies were conducted following the derailment of a railroad car north of Dunsmuir, California on July 4, 1991, when approximately 19,000 to 27,000 Kg of metam sodium spilled into the Sacramento River. MITC concentrations in water samples collected following the spill, reach a maximum of 5500 ppb three days after the spill at the northern most inlet of Shasta Lake, and decreased to 8 ppb six days later. None of the degradates of metam sodium in water samples analyzed were detected 1 week after the spill (del Rosareo et al., 1994 and Segawa et at., 1991). Based on non-targeted survey data , no MITC has been detected in 14864 ground water samples collected from 45 states over several years for Pesticides in Ground Water Data Base (PGWDB). At present time, MITC is not included in the National Water Quality Assessment Program (NAWQA) of United States Geological Survey (www.water.wr.usgs.gov), and it is also not included in the National Pesticide Survey.

VI. Aquatic Exposure and Risk Assessment

a. Aquatic (Acute/Chronic Hazard Summary)

The available toxicity data are listed in Appendix I. Some data are on metam-sodium, some data are on metam-potassium (and considered equivalent to metam-sodium), and some data are on MITC, the degradate of both metam-sodium and metam-potassium (and the substance responsible for most of the toxicity to both target and nontarget organisms).

The aquatic risk assessment will be largely based on MITC, the substance that is both expected to reach water bodies in larger concentrations than parent material and that is generally considerably more toxic than parent material. MITC is considered very highly toxic to aquatic invertebrates (e.g., *Daphnia* EC50 = 55 ppb) and freshwater fish (e.g., rainbow trout LC50 = 51.2 ppb). The chronic NOAEC for *Daphnia* is 25 ppb.

Estuarine/marine data are not available for MITC. Available data on metam-potassium indicate that it is slightly toxic to estuarine/marine fish (sheepshead minnow LC50 =30 ppm), and moderately toxic to both molluscs (oyster EC50 = 6.45 ppm) and crustaceans (mysid shrimp LC50 = 3.23 ppm).

Aquatic plant testing with MITC indicates that the most sensitive non-vascular species tested is the algae *Scenedesmus subspicatus*. The EC50, based on cell density, is 0.254 ppm. The available test on a vascular test species, duckweed, indicates an MITC EC50 of 0.59 ppm, based on number of fronds and growth.

b. Risk to Aquatic Organisms (Acute/Chronic)

Tables 8 and 9 provide acute and chronic RQ values for MITC exposure to freshwater and estuarine/marine species relative to tomato, onion, potato, and turf use patterns of metam-sodium (pre-plant fumigations of the soil), based on PRZM/EXAMS exposure modeling.

Three of the four modeled sites (tomatoes, onions, and turf) exceed Levels of Concern for both aquatic invertebrates and fish. Specifically, tomatoes exceeds all three LOCs (endangered species, restricted use, and acute risk), while onions and turf exceed the endangered species and restricted use LOCs only.

Table 8. Acute and chronic risk RQ's for evaluating toxic risk of MITC exposure to aquatic invertebrates. RQ's are based on Daphnia EC_{50} = 55 ppb and the Daphnia NOAEC = 25 ppb. EEC values are generated from PRZM/EXAMS.

Crop App. Rate (lbs ai/A of metam-sodium); # Apps.	**Organism**	**EC_{50} (ppb)**	**NOAEC (ppb)**	**EEC Peak (ppb)**	**EEC 21-Day Ave. (ppb)**	**Acute RQ (EEC/ LC_{50})**	**Chronic RQ (EEC/NOAEC)**
Tomato (FL) 320 (1)	Freshwater	55	25	35.11	5.47	**0.64*****	**0.22**
Onion (CA) 320 (1)	Freshwater	55	25	10.39	2.41	**0.19****	**0.096**
Potato (ID) 320 (1)	Freshwater	55	25	1.54	0.34	**0.028**	**0.014**
Turf (PA) 320 (1)	Freshwater	55	25	7.98	1.75	**0.15****	**0.07**

*Exceeds acute endangered species LOC (≥ 0.05)
**Exceeds acute endangered species LOC and acute restricted use LOC (≥ 0.1)
***Exceeds acute endangered species LOC, acute restricted use LOC, and acute risk LOC (≥ 0.5)
+Exceeds chronic risk LOC (≥ 1)

Table 9. Acute and chronic risk RQ's for evaluating toxic risk of MITC exposure to fish. RQ's are based on rainbow trout LC_{50} = 51.2 ppb. EEC values are generated from PRZM/EXAMS.

Crop App. Rate (lbs ai/A); # Apps.	**Organism**	**EC_{50} (ppb)**	**NOAEC (ppb)**	**EEC Peak (ppb)**	**EEC 60-Day Ave. (ppb)**	**Acute RQ (EEC/ LC_{50})**	**Chronic RQ (EEC/NOAEC)**
Tomato (FL) 320 (1)	Freshwater	51.2	NA	35.11	1.93	**0.69*****	**NA**
Onion (CA) 320 (1)	Freshwater	51.2	NA	10.39	0.86	**0.20****	**NA**
Potato (ID) 320 (1)	Freshwater	51.2	NA	1.54	0.12	**0.03**	**NA**
Turf (PA) 320 (1)	Freshwater	51.2	NA	7.98	0.62	**0.16****	**NA**

*Exceeds acute endangered species LOC (≥ 0.05)

**Exceeds acute endangered species LOC and acute restricted use LOC ($\geq$ 0.1)
***Exceeds acute endangered species LOC, acute restricted use LOC, and acute risk LOC ($\geq$ 0.5)
+Exceeds chronic risk LOC ($\geq$ 1)

Six aquatic incidents reports involving metam-sodium are included in EFED's Ecological Incident Information System (EIIS) database. They have certainty indices ranging from 1 (unlikely) to 4 (highly probable).

1) I006515-001. This is the only incident report with a certainty index of 4. It involved a railroad tank car spill in which thousands of fish (as well as most insects and some plants) were killed in a 42-mile stretch of the Sacramento River in California in 1991. While not representative of agricultural applications, this incident shows clearly that metam-sodium has the ability to kill large numbers of aquatic organisms if the chemical gets into water in large quantities.

2) I005525-016. This incident report is a summary report only, but cites the death of over 1000 fish, including trout, suckers, squawfish, and sculpin in Siskiyou and Shasta counties in California in 1991. It very likely refers to the same railroad tank car spill cited above. It provides the additional information of fish species involved.

3) I012648-001. This incident report involved a phone call in which a Florida fish farm representative claimed that the use of metam-sodium nearby resulted in several fish kills from 1994 - 2001. The EIIS database lists this as a certainty index 2 (Possible) incident.

4) I008259-001. This incident report under 6(a)(2) (from a registrant) cites a claim from a Florida fish farm owner that 2700 hybrid bass were killed after metam-sodium was applied within 300 feet of the fish tanks. The owner suspected that drift occurred (i.e., of MITC, the toxic degradate of metam-sodium that off-gasses) and that his aeration system picked it up and re-dissolved it into the fish tanks. Also cited in the report is a pump malfunction that apparently interrupted water and oxygen circulation. The EIIS database lists this as a certainty index 2 (Possible) incident.

5) I011162-001. This incident report under 6(a)(2) (from a registrant) cites a claim from a Florida fish farm owner that approximately 400 striped bass were killed after metam-sodium was applied within about 600 feet of the fish tank. Although reportedly most of the tanks receive air from a common source, mortality was reported in only one of 94 tanks. The EIIS database lists this as a certainty index 1 (Unlikely) incident.

6) I008275-003. This incident report under 6(a)(2) (from a registrant) cites a reported pond contamination and a fish kill following metam-sodium application. Very few details were provided, although it states that USFWS was notified when the incident occurred. The EIIS database lists this as a certainty index 2 (Possible) incident.

The tank car spill incident shows clearly that metam-sodium has the ability to kill large numbers of aquatic organisms if the chemical gets into water in large quantities. However, a tank car spill incident is not representative of agricultural applications. The fish farm incidents show the potential for off-gassed MITC to be inadvertently drawn into man-made aeration systems, resulting in possible fish mortality.

The exceeded LOCs indicate that under conventional agricultural use of metam-sodium for pre-plant fumigation, sufficient MITC could reach a typical farm pond to cause the death of aquatic invertebrates and fish, based on modeling.

c) Aquatic Plants

Exposure to nontarget aquatic plants may occur through runoff or spray drift from adjacent treated sites. An aquatic plant risk assessment for acute risk is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. Nonvascular acute aquatic plant risk assessments are performed using either algae or a diatom, whichever is the most sensitive species. An aquatic plant risk assessment for acute- endangered species is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. There are no nonvascular plant species on the endangered species list. Runoff and drift exposure is computed from PRZM (Pesticide Root Zone Model) and EXAMS (Exposure Analysis Modeling System). The risk quotient is determined by dividing the pesticide's peak concentration in water by the plant EC_{50} or NOAEC value.

Acute risk quotients for vascular and nonvascular plants are tabulated below.

Table 10. Acute Risk Quotients for aquatic vascular plants based upon the duckweed *Lemna gibba* EC50 (0.59 ppm) and NOAEC (0.09 ppm).

Site / Rate of Application (No. of Applications)	Species	EC50 (ppb)	EEC (ppb)	NOAEC (ppb)	Endangered Species RQ (EEC/NOAEC)	Nontarget Plant RQ (EEC/EC50)
Tomato	Duckweed	590	35.11	90	0.390	0.060
Onion	Duckweed	590	10.39	90	0.115	0.018
Potato	Duckweed	590	1.54	90	0.017	0.003
Turf	Duckweed	590	7.98	90	0.089	0.014

The acute risk and acute endangered species level of concerns for aquatic vascular plants are not exceeded.

Table 11. Acute Risk Quotients for aquatic plants based upon the algae *Scenedesmus subspicatus* EC50 (0.254 ppm) and NOAEC (0.125 ppm).

Site / Rate of Application (No. of Applications)	Species	EC50 (ppb)	EEC (ppb)	NOAEC (ppb)	Endangered Species RQ (EEC/NOAEC)	Nontarget Plant RQ (EEC/EC50)
Tomato	Algae	254	35.11	125	0.281	0.138
Onion	Algae	254	10.39	125	0.083	0.041
Potato	Algae	254	1.54	125	0.012	0.006
Turf	Algae	254	7.98	125	0.064	0.031

The acute risk and acute endangered species level of concerns for aquatic non-vascular plants are not exceeded. However, Core studies with *Anabaena flos-aquae* and *Selenastrum capricornutum* and studies with the marine diatom *Skeletonema costatum* and a freshwater diatom are still needed to evaluate risk to aquatic plants.

VII Terrestrial Exposure and Risk

a. Terrestrial Hazard Summary

The available toxicity data are listed in Appendix I. Metam-sodium is considered moderately toxic on an acute oral basis (bobwhite quail LD50 = 211 mg/kg). On a subacute dietary basis, it is considered up to slightly toxic, based on the lowest value available (mallard = 1835.7 ppm). However, dietary data are not used in the risk assessment, since dietary exposure is not expected to be a major route of exposure, due to the rapid conversion of metam-sodium to MITC and the volatility and off-gassing of MITC. Metam-sodium is considered practically nontoxic to the honeybee on an acute contact basis (LD50 = 36.2 ug/bee).

Mammalian toxicity data (reviewed by HED) indicate that metam-sodium has an acute oral LD50 of 780 mg/kg in male rats and an acute inhalation LC50 of 2.27 mg/L in rats. MITC has an acute oral LD50 of 55 mg/kg in female rats and an acute inhalation LC50 of 0.54 mg/L. The MITC NOAEL based on a 28-day subchronic inhalation study on rats is 5.4 mg/kg/day.

b. Risk to Avian Species

The main route of exposure of birds is likely to be from inhalation of MITC off-gassing from metam-sodium treated fields. However, avian inhalation data are not available. EFED has used the established LD50/square foot method for mammals as a rough risk calculation screen (see below). However, this screen has not been done for birds since the necessary acute oral value for birds with MITC is also not available. See the Integrated Risk Characterization for analysis of inhalation risk to mammals and how this relates to potential risk to birds.

c. Risk to Mammals

EFED has used the established LD50/square foot risk assessment method for mammals as a risk calculation screen. This method is considered to cover all routes of exposure, although it uses an acute oral toxicity value. It is typically used for granular and similar products, but it is considered acceptable for use as a screen for MITC. Uncertainties of the method, in general, include 1) non-oral routes of exposure may be either more or less hazardous than the oral route, and 2) an organism would not typically take up all the toxicant from any given square foot, and the amount of toxicant in this unit of area may be more or less than that which an organism receives overall as a dose. For evaluating exposure to a highly volatile chemical applied below ground, there is added uncertainty since all the chemical applied is not available at the surface at any one time, for example. It's value for the present assessment is as a preliminary screen to confirm whether a refined route-specific (e.g., inhalation) analysis is appropriate.

Using the 150.3 lb of MITC equivalent/A used in calculating aquatic EECs (see previous Water Resource Assessment), there would be 1564.9 mg MITC/square foot (given 43,560 square feet/A and

453,590 mg/lb). This exposure amount is divided by the product of acute oral LD50 for mammals (55 mg/kg) and body weight of mammal (in kg) to calculate risk quotients. Three mammal body weights are assessed: 15 g, 35 g, and 1000 g. The resulting risk quotients for these three sizes of mammals are 1,897, 813, and 28, respectively. These far exceed the acute risk LOC of 0.5, as well as the acute restricted use LOC of 0.2 and the acute endangered species LOC of 0.1. Thus, this preliminary screen indicates a potential for concern for risk to wild mammals.

As with birds, the main route of wild mammal exposure is likely to be from inhalation of MITC off-gassing from metam-sodium treated fields. Mammalian inhalation toxicity data are available. However, EFED does not currently have established LOCs based on inhalation exposure. Nevertheless, an inhalation risk concern for wild mammals has been identified. See the Integrated Risk Characterization for the more refined assessment of risk based on inhalation exposure.

d. Risk to Non-target Insects

EFED does not do risk assessments on insects. However, it appears that metam-sodium has a very low potential for acute risk to adult honeybees. Since metam-sodium is applied to bare fields, there would be no flowering crop to attract bees. Further, based on available data, metam-sodium is considered practically nontoxic to honey bees on an acute dermal basis. Any non-target insect in the treated soil would likely be at a high risk of mortality from the degradate MITC.

e. Risk to Plants

Nontarget plants off-site have the potential to be exposed when the degradate MITC off-gasses from treated fields. Terrestrial plant toxicity data have not been submitted.

Three plant incidents are included in the EIIS database:

1) I011510-001. This incident report under 6(a)(2) (from a registrant) cites an incident in which 30 acres of pine seedlings in Texas were alleged to be damaged by drift (presumably of MITC) from a metam-sodium application in which no water seal was used. It is categorized in the EIIS database as category 3 (Probable) incident.

2) I011838-056. This incident report under 6(a)(2) (from a registrant) cites an incident in which 80 acres of peanuts were damaged in North Carolina. Metam-sodium was apparently one of five pesticides applied and is listed in the EIIS database as a possible contributor.

3) I012457-005. This incident report under 6(a)(2) (from a registrant) cites an incident in which 120 acres of peanuts were damaged in North Carolina. Metam-sodium was apparently one of two pesticides applied and is listed in the EIIS database as a possible contributor.

The pine seedling incident above indicates the potential for MITC off-gassing to pose a risk to nearby terrestrial plants. Terrestrial plant toxicity data is needed to conduct a risk assessment on terrestrial plants.

APPENDIX I: Ecological Hazard Data

Overview

The toxicity testing required does not test all species of birds, fish, mammals, invertebrates, and plants. Only two surrogate species for birds (bobwhite quail and mallard) are used to represent all bird species (over 1000 in the US, including subspecies), three species of freshwater fish (rainbow trout, bluegill sunfish and fathead minnow) are used to represent all freshwater fish species (over 900 in the US), and one estuarine/marine fish species (sheepshead minnow) is used to represent all estuarine/marine fish (over 300 in the US). The surrogate species for terrestrial invertebrates is the honey bee, for freshwater invertebrates the surrogate species is usually the waterflea (*Daphnia magna*) and for estuarine/marine invertebrates the surrogate species are mysid shrimp and eastern oyster. These four species are used to represent all invertebrate species (over 10,000 in the US). For plants, there are ten surrogate species used for all terrestrial plants and five surrogate species used for all aquatic plants. There are over 20,000 plant species in the US which includes flowering plants, conifers, ferns, mosses, liverworts, hornworts and lichens with over 27,000 species of algae worldwide.

The surrogate species testing scheme used in this assessment assumes that a chemical's mechanism of action and toxicity found for avian species is similar to that in all reptiles (over 300 species in the US). The same assumption applies to amphibians (over 200 species in the US) and fish; the tadpole stage of amphibians is assumed to have the same sensitivity as a fish. Therefore, the results from toxicity tests on surrogate species are considered applicable to other member species within their class and are extrapolated to reptiles and amphibians. The US species numbers noted in this section were taken from the Natureserve website (www.natureserve.org NatureServe: An online encyclopedia of life [web application].2000) and the worldwide species number from Ecological Planning and Toxicology, Inc.1996.

In the following sections, the shaded values in the tables are the ones used in the current risk assessment.

a. Toxicity to Terrestrial Animals

i. Birds, Acute and Subacute

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of metam-sodium to birds. The avian oral LD_{50} is an acute, single-dose laboratory study designed to estimate the quantity of toxicant required to cause 50% mortality in a test population of birds. The preferred test species is either the mallard, a waterfowl, or bobwhite quail, an upland gamebird. The TGAI is administered by oral intubation to adult birds, and the results are expressed as LD_{50} milligrams (mg) active ingredient (a.i.) per kilogram (kg) of body weight. Toxicity category descriptions are the following:

If the LD_{50} is *less than 10 mg a.i./kg*, then the test substance is *very highly toxic*.
If the LD_{50} is *10-to-50 mg a.i./kg*, then the test substance is *highly toxic*.
If the LD_{50} is *51-to-500 mg a.i./kg*, then the test substance is *moderately toxic.*
If the LD_{50} is *501-to-2,000 mg a.i./kg*, then the test substance is *slightly toxic.*
If the LD_{50} is *greater than 2,000 mg a.i./kg*, then the test substance is *practically nontoxic.*

Table 1: Avian Acute Oral Toxicity - Technical

Species	**% ai**	**LD_{50} (mg a.i./kg)**	**Toxicity Category**	**MRID/Accession (AC) No. Author/Year**	**Study Classification[1]**
Mallard Duck *(Anas platyrhynchos)*	42.2	211	moderately toxic	41476402/Munk/1985	Core

[1] Core means study satisfies guideline. Supplemental means study is scientifically sound, but does not satisfy guideline.

The guideline (71-1a) is satisfied for metam-sodium (MRIDs 41476402). However, acute oral testing on MITC is needed for risk assessment.

Two dietary studies using the TGAI are usually required to establish the toxicity of pesticides to birds. These avian dietary LC_{50} tests, using the mallard and bobwhite quail, are acute, eight-day dietary laboratory studies designed to estimate the quantities of toxicant in the feed required to cause 50% mortality in the two respective test populations of birds. The TGAI is administered by mixture to juvenile birds' diets for five days followed by three days of "clean" diet, and the results are expressed as LC_{50} parts per million (ppm) active ingredient (a.i.) in the diet. Toxicity category descriptions are the following:

If the LC_{50} is *less than 50 ppm a.i.*, then the test substance is *very highly toxic*.
If the LC_{50} is *50-to-500 ppm a.i.*, then the test substance is *highly toxic*.
If the LC_{50} is *501-to-1,000 ppm a.i.*, then the test substance is *moderately toxic.*
If the LC_{50} is *1001-to-5,000 ppm a.i.*, then the test substance is *slightly toxic.*
If the LC_{50} is *greater than 5,000 ppm a.i.*, then the test substance is *practically nontoxic.*

Results of these tests are tabulated below.

Table 2: Avian Subacute Dietary Toxicity - Technical

Species	% ai	LC50(ppm)	Toxicity Category	MRID/Accession (AC) No. Author/Year	Study Classification[1]
Mallard Duck *(Anas platyrhynchos*)	42.2	1835.7	slightly toxic	41476403/Munk/1986	Suppl.
Mallard Duck *(Anas platyrhynchos*)	43	> 5000	practically non-toxic	42914001/Pederson & Slatycki/1993	Core
Mallard Duck *(Anas platyrhynchos*)	Tech	> 5000	practically non-toxic	00022923/USFWS/1975	Core
Northern Bobwhite Quail *(Colinus virginianus*)	43	> 5000	practically non-toxic	42914002/Pederson & Solatycki/1993	Core
Northern Bobwhite Quail *(Colinus virginianus*)	42.2	> 2110	slightly toxic or less	41476401/Munk/1986	Suppl.
Northern Bobwhite Quail *(Colinus virginianus*)	Tech	> 5000	practically non-toxic	00022923/USFWS/1975	Core

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline)

The guideline (71-2a,b) is satisfied. However, dietary exposure is not the expected route of avian exposure and the above data are not used in the current risk assessment. Inhalation toxicity data on MITC are needed to improve the certainty of the current risk assessment based on MITC inhalation.

ii. Birds, Chronic

Chronic/sub-chronic inhalation testing with MITC is needed to assess risk to birds because of the potential for repeated or continuous exposure resulting from multiple fields being treated on differing days within a given geographic area.

iii. Mammalian Toxicity Data (from HED)

ACUTE TOXICITY

1. Metam Sodium

Acute Toxicity of Metam Sodium (P. C. Code 039003)

Guideline No.	Study Type	MRIDs #	Results	Toxicity Category
81-1	Acute Oral-Rat	41277002	LD_{50} = 780 mg/kg (male rats) 845 mg/kg (female rats)	III

81-2	Acute Dermal-Rat	41277003	LD_{50} = >2020 mg/kg	III
81-3	Acute Inhalation-Rat	41277004	LC_{50} = 2.27 mg/L	III
81-4	Primary Eye Irritation	41277005	No corneal/iris involvement; all irritation was absent by 7 days	III
81-5	Primary Skin Irritation-Rabbit	41277006	non-irritating to the skin of male rabbits	IV
81-6	Dermal Sensitization	41277007	Negative in guinea pigs	
81-8	Acute Neurotoxicity-Rat	42977801 and 42977802	The LOAEL of 22 mg/kg is based on reduced ambulatory and total motor activity observed in male & female rats. The NOAEL < 22 mg/kg and was not achieved in this study.	

2. MITC

Acute Toxicity of Methyl Isothiocyanate (PC Code 068103)

Guideline No.	Study Type	MRID #(S).	Results	Toxicity Category
81-1	Acute Oral-Rat	162331	LD_{50} = 82 mg/kg % 55 mg/kg &	II
81-2	Acute Dermal-Rat	16233042442501	LD_{50} = 136-436 mg/kg % 181 mg/kg &	I
81-3	Acute Inhalation-Rat	16232742365605	LC_{50} = 0.54 mg/L	II
81-4	Primary Eye Irritation	162328	corrosion of the cornea and conjuctivae	I
81-5	Primary Skin Irritation	162329	all animals died within one hour	I
81-6	Dermal Sensitization	Not available		

SUMMARY OF TOXICOLOGY ENDPOINT SELECTION

1. Metam Sodium/Metam Potassium

Summary of Toxicology Endpoint Selection for
Metam Sodium (PC Code 39003) and *Metam Potassium (PC Code 39002)*

Exposure Scenario	Dose Used in Risk Assessment	Special FQPA SF[c] and Level of Concern for Risk Assessment	Study and Toxicologial Effects
Acute Dietary general population including infants and children	Acute dietary endpoints were not selected since the use-pattern does not indicate potential for dietary exposure.		
Chronic Dietary all populations	Chronic dietary endpoints were not selected.since the use-pattern does not indicate potential for dietary exposure.		
Incidental Oral Short- and Intermediate-Term (1 - 30 Days; 1-6 Months) Residential Only	Short- and intermediate term incidental oral endpoints were not selected since the use-pattern does not indicate potential for this exposure scenario.		
Dermal Short-Term (1 - 30 days) Residential and Occupational	Maternal NOAEL[a,e]= 4.22 mg/kg/day Dermal absorption factor = 2.5%	**Residential** LOC for MOE[b] = N/A **Occupational** = LOC[d] for MOE = 100	**Developmental toxicity in rat (MRID 41577101)** LOAEL[g] = 16.88 mg/kg/day based on reduced body weight gain and decreased food efficiency in maternal rats
Dermal Intermediate-Term (1 - 6 Months) Residential and Occupational	Oral NOAEL[a]= 0.1 mg/kg/day Dermal absorption factor = 2.5%	**Residential** LOC for MOE = N/A **Occupational** = LOC for MOE = 100	**Chronic toxicity in dog (MRID 43275801)** LOAEL = 1 mg/kg/day based on based on increased ALT and microscopic changes in the liver in females.
Dermal Long-Term (> 6 Months) Residential and Occupational	Oral NOAEL[a]= 0.1 mg/kg/day Dermal absorption factor = 2.5%	**Residential** LOC for MOE = N/A **Occupational** = LOC for MOE = 100	**Chronic toxicity in dog (MRID 43275801)** LOAEL = 1 mg/kg/day based on based on increased ALT and microscopic changes in the liver in females.

Exposure Scenario	Dose Used in Risk Assessment	Special FQPA SF[c] and Level of Concern for Risk Assessment	Study and Toxicologial Effects
Inhalation Short-, Intermediate, and Long-Term (1 - 30 days, 1-6 Months, and > 6 Months) Residential and Occupational	Inhalation NOAEL= 6.5 mg/m^3 (1.11 mg/kg/day)	**Residential** LOC for MOE = N/A **Occupational** = LOC for MOE = 100	**90-day inhalation study (MRID 00162041)** LOAEL =45 mg/m^3 (7.71 mg/kg/day) in females based on histopathological changes in the nasal passages (ie, mucigenic hyperplasia) and changes in clinical chemistry.
Cancer	**Classification:** Probable human carcinogen (B2) **Q1* =**$1.98x10^{-1}$ in human equivalents converted from animals		

a Since an oral NOAEL was selected, a dermal absorption factor of 2.5% should be used in route-to-route extrapolation.; b Margin of Exposure (MOE) = 100 [10x for interspecies extrapolation and 10x for intraspecies variations and 1x special hazard-based FQPA safety factor.]; c FQPA SF = Special FQPA safety factor is not applicable. d LOC = level of concern; e NOAEL = no observed adverse effect level; f NA = Not Applicable; g LOAEL = lowest observed adverse effect level.

2. MITC

Summary of Toxicology Endpoint Selection for Methyl isothiocyanate (PC Code 068103)

Exposure Scenario	Dose Used in Risk Assessment	Special FQPA SF[b] and Level of Concern for Risk Assessment	Study and Toxicologial Effects
Acute Dietary <u>general population</u> including infants and children	Dietary exposure is not expected for MITC		
Chronic Dietary (All populations)	Dietary exposure is not expected for MITC		
Incidental Oral Short-Term (1 - 30 Days)	Incidental oral exposure is not expected for MITC		
Incidental Oral Intermediate-Term (1 - 6 Months)	Incidental oral exposure is not expected for MITC		
Dermal Short-Term (1 - 30 days), Intermediate-Term (1 - 6 Months) Long-Term (> 6 Months)	No dermal hazard via typical dermal contact with MITC is expected. Unprotected skin could exposed to MITC vapor; however this exposure can not, at this time, be quantified.		
Inhalation Short-Term (1 - 30 days) Intermediate-Term (1 - 6 Months) Long-Term (>6 Months)	Inhalation NOAEL= 5.4 mg/kg/day	**Residential** LOC for MOE = 1000[h] **Occupational** LOC for MOE = 100[g]	**Subchronic inhalation toxicity- rat with *MITC* (MRID 45314802)** LOAEL = 27 mg/kg/day based on based on persistent clinical signs, body weight changes, and gross and histopathological lesions
Cancer	**Classification:** Probable human carcinogen (B2) Q1* =3.54 x10^{-1} in human equivalents converted from animals		

a Margin of Exposure (MOE) or Uncertainty Factors (UF) = 1000 [10x for interspecies extrapolation, 10x for intraspecies variations, 10x NOAEL to LOAEL factor and 1x special hazard-based FQPA safety factor.]; b FQPA SF = Special FQPA safety factor is not applicable, c LOC = level of concern; d NOAEL = no observed adverse effect level; e N/A = Not Applicable; f LOAEL = lowest observed adverse effect level; g Margin of Exposure (MOE) or Uncertainty Factors (UF) = 100 [10x for interspecies extrapolation, 10x for intraspecies variations.]; h Margin of Exposure (MOE) or Uncertainty Factors (UF) = 1000 [10x for interspecies extrapolation, 10x for intraspecies variations, 10x database uncertainty factor and 1x special hazard-based FQPA safety factor.].

b. Toxicity to Freshwater Aquatic Animals

i. Freshwater Fish, Acute

Two freshwater fish toxicity studies using the TGAI are required to establish the toxicity of metam-sodium to fish. It has been determined that data on metam-potassium satisfy the data requirement for metam-sodium (10/1/93 EFED Memorandum). The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Results of these tests are tabulated below. The toxicity category descriptions for freshwater and estuarine/marine fish and aquatic invertebrates, are defined below in parts per million (ppm).

If the LC_{50} is *less than 0.1 ppm a.i.*, then the test substance is *very highly toxic*.
If the LC_{50} is *0.1-to-1.0 ppm a.i.*, then the test substance is *highly toxic*.
If the LC_{50} is *greater than 1 and up through 10 ppm a.i.*, then the test substance is *moderately toxic.*
If the LC_{50} is *greater than 10 and up through 100 ppm a.i.*, then the test substance is *slightly toxic.*
If the LC_{50} is *greater than 100 ppm a.i.*, then the test substance is *practically nontoxic.*

Table 3: Freshwater Fish Acute Toxicity - Metam-potassium Technical

Species/ Flow-through or Static	**% ai**	**LC_{50} (ppm) / (C.I.)**	**Toxicity Category**	**MRID/Accession (ACC) No. Author/Year**	**Study Classification**
Bluegill Sunfish *(Lepomis macrochirus)*/	54.0	108	practically nontoxic	42363201/Lintott & Wheat/1992	Core
Rainbow Trout (Oncorhynchus sp.)/	54.0	62.2	Slightly toxic	42363202/Carr & Wheat/1992	Core

The requirement for two freshwater fish acute toxicity studies has been satisfied.

Additionally, studies have been conducted on MITC, the principal degradate of metam-sodium. This is the principal chemical to which fish are likely to be exposed, based on current modeling. The studies are summarized in the following table.

Table 4: Freshwater Fish Acute Toxicity - MITC

Species/ Flow-through or Static	**% ai**	**LC_{50} (ppm)**	**Toxicity Category**	**MRID/Accession (ACC) No. Author/Year**	**Study Classification**
Bluegill Sunfish *(Lepomis macrochirus)*/flow-through	94.9	0.142	highly toxic	44523412 (=42058001)/Schupner & Stachura/1991	Core

Species/ Flow-through or Static	% ai	LC_{50} (ppm)	Toxicity Category	MRID/Accession (ACC) No. Author/Year	Study Classification
Rainbow Trout (Oncorhynchus sp.)/flow-through	94.9	0.094	very highly toxic	44523413 (=42058002)/Schupner & Stachura/1991	Core
Rainbow Trout/(Oncorhynchus sp.)/static renewal	99.6	0.0512	very highly toxic	45919420/Zok/2002	Suppl.

ii. Freshwater Fish, Chronic

A freshwater fish early life-stage test is required for MITC because this degradate is expected to be transported to water from the intended use site, and one or more of the following conditions are met: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent, (2) any aquatic acute LC_{50} or EC_{50} is less than 1 ppm, and/or (3) the EEC in water is equal to or greater than 0.01 of any acute LC_{50} or EC_{50} value. Due to the rapid degradation of metam-sodium to MITC in the presence of water, the required test material is MITC. The preferred test species is rainbow trout. A non-guideline 28-day subchronic study with rainbow trout has been submitted. However, this study (MRID 45634002) is considered invalid due to insufficient analytical data and MITC stability was not adequately assessed.

The fish early life-stage is a laboratory test designed to estimate the quantity of toxicant required to adversely effect the reproduction of a test population of fish. The test should be performed using flow-through conditions. The test material is administered into water containing the test species, providing exposure throughout a critical life-stage, and the results, generally, are expressed as a No Observed Adverse Effect Concentration (NOAEC) in parts per million or parts per billion of active ingredient. The No Observed Adverse Effect Concentration represents an exposure concentration, at or below which biologically significant effects will not occur to species of similar sensitivities.

(iii) Freshwater Invertebrates, Acute

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of metam-sodium to aquatic invertebrates. The preferred test organism is *Daphnia magna*, but early instar amphipods, stoneflies, mayflies, or midges may also be used. Results of this test are tabulated below.

Table 5: Freshwater Invertebrate Acute Toxicity - Metam-sodium (or metam-potassium*)

Species/ Flow-through or Static	% ai	LC_{50} (ppm)	Toxicity Category	MRID/Accession (ACC) No. Author/Year	Study Classification
Daphnid *(Daphnia magna)*/static	NR	2.36	moderately toxic	41106203/Bias & Merz/1985	Supplemental
Cypridopsis vidua/static	100	0.035	very highly toxic	40098001/USFWS/1986	Supplemental
Daphnid *(Daphnia magna)*/flow-through	54	6.34*	moderately toxic	42680601/Ward/1993	Core

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline).

With a lowest EC_{50} of 0.035 ppm, metam-sodium is categorized very highly toxic to freshwater aquatic invertebrates on an acute basis. The guideline (72-2a) is satisfied.

Additionally, studies have been conducted on MITC, the principal degradate of metam-sodium and the focus of the present risk assessment. They are summarized in the following table.

Table 6: Freshwater Invertebrate Acute Toxicity - MITC

Species/ Flow-through or Static	% ai	LC_{50} (ppm)	Toxicity Category	MRID/Accession (ACC) No. Author/Year	Study Classification
Daphnid *(Daphnia magna)*/flow-through	95	0.055	very highly toxic	41819302/Schupner/1991	Core
Daphnid *(Daphnia magna)*/static renewal	99.6	0.076	very highly toxic	45919419/Dohmen/2002	Supplemental

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline).

With a lowest EC_{50} of 0.055 ppm, MITC is categorized very highly toxic to freshwater aquatic invertebrates on an acute basis. The guideline (72-2a) is satisfied.

iv. Freshwater Invertebrate, Chronic

A freshwater aquatic invertebrate life-cycle test is required for MITC because this degradate is expected to be transported to water from the intended use site, and one or more of the following conditions are met: (1) the pesticide is intended for use such that its presence in water is likely to be continuous or recurrent, (2) any aquatic acute LC_{50} or EC_{50} is less than 1ppm, and/or (3) the EEC in water is equal to or greater than 0.01 of any acute LC_{50} or EC_{50} value. Due to the rapid degradation of metam-sodium to MITC in the presence of water, the required test material is MITC. The preferred test species is *Daphnia magna*. Results of this test are tabulated below.

Table 7: Freshwater Aquatic Invertebrate Life-Cycle Toxicity- MITC

Species/Static Renewal or Flow-through	% ai	21-day NOAEC/LOAEC (ppm)	Endpoints Affected	MRID/Accession (AC) No. Author/Year	Study Classification[1]
Daphnid(*Daphnia magna*/ static renewal	NR	0.025/>0.025 0.025/0.050	Reproduction Parental mortality	45634001/Jatzek/2001	Supplemental

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline)

The guideline (72-4b) is not fulfilled, since mean measured concentrations were not determined, the stability of the test substance under actual use conditions was not assessed, and terminal growth measurements were not obtained.

c. Toxicity to Estuarine and Marine Animals

i. Estuarine and Marine Fish, Acute

Acute toxicity testing with estuarine/marine fish is required for metam-sodium since the active ingredient and or degradates are expected to reach the marine/estuarine environment due to its expected use in coastal counties. The preferred test species is the sheepshead minnow. Results of this test are tabulated below.

Table 8: Summary of acute 96-hr toxicity tests for Estuarine/Marine Fish (metam-potassium)

Species	% ai	LC_{50} ppm	Toxicity Category	MRID No. Author/year	Classification
Sheepshead Minnow/ *(Cyprinodon variegatus)*/flow-through	54	30	slightly toxic	42436301/Sutherland & Lintott/1992	Core

Data are needed for the principal degradate MITC.

ii. Estuarine and Marine Fish, Chronic

An estuarine/marine fish early life-stage toxicity test using MITC is reserved, pending submission and review of freshwater fish chronic testing.

iii. Estuarine and Marine Invertebrates, Acute

Acute toxicity testing with estuarine/marine invertebrates is required for metam-sodium because it is expected to reach the marine/estuarine environment due to its expected use in coastal counties. The preferred test species are mysid shrimp and eastern oyster. Results of these tests are tabulated below.

Table 9: Estuarine/Marine Invertebrate Acute Toxicity - Metam-potassium

Species/Static or Flow-through	% ai.	LC50/ EC50 (ppm)	Toxicity Category	MRID No./ Author/Year	Study Classificatio n
Eastern oyster *(Crassostrea virginica)*/flow-through (shell deposition)	54	6.45	moderately toxic	42632201/Lintott & Ward/1993	Core
Mysid *(Mysidopsis bahia)*/flow-through	54	3.23	moderately toxic	42476301/Jaurovi sech & Lintott/1992	Core

Data are needed for the principal degradate MITC.

iv. Estuarine and Marine Invertebrate, Chronic

An estuarine/marine invertebrate life-cycle toxicity test (Guideline 72-4b) using MITC is reserved, pending submission and review of Core freshwater invertebrate chronic testing.

d. Toxicity to Plants

i. Terrestrial Plants

Terrestrial plant Tier I seedling emergence and vegetative vigor testing of a Typical End-Use product (TEP) is currently recommended for all pesticides having outdoor uses (EFED Policy, Keehner. July 1999). For seedling emergence and vegetative vigor testing, the following plant species and groups should be tested: (1) six species of at least four dicotyledonous families, one species of which is soybean (*Glycine max*) and the second is a root crop, and (2) four species of at least two monocotyledonous families, one of which is corn (*Zea mays*). Tier I tests measure the response of plants, relative to a control, at a test level that is equal to the highest use rate expressed as pounds active ingredeint per acre (lbs ai/A). Tier II studies are required if the Tier I studies indicate any of the test species, when exposed to the test material, displayed a $25% inhibition or over-enhancement of various growth parameters as compared to the control. This guideline has not been satisfied.

ii. Aquatic Plants

Aquatic plant testing is recommended for all pesticides having outdoor uses (EFED Policy, Keehner. July 1999). The tests are performed on species from a cross-section of the aquatic plant population. The preferred test species are duckweed (*Lemna gibba*), marine diatom (*Skeletonema costatum*), blue-green algae (*Anabaena flos-aquae*), freshwater green alga (*Selenastrum capricornutum*), and a freshwater diatom. Tier I aquatic plant testing is a maximum dose test designed to quickly evaluate the toxic effects to the test species in terms of growth and reproduction and to determine the need for additional aquatic plant testing. Tier II aquatic plant testing is a multiple dose test of the plants species that showed a phytotoxic effect to the pesticide being tested at the Tier I level. Tier II testing is designed to determine the detrimental effect levels of the chemical on the aquatic plants which showed a greater than 50% detrimental effect in Tier I testing.

For metam-sodium, four studies on the degradate MITC have been submitted. They are summarized in the following table.

Table 10: Aquatic Plant Toxicity (Tier II) - MITC

Species/duration	% A. I.	EC_{50}/NOAEC (ppm) (nominal or measured)	MRID No. Author/year	Classification
Vascular Plants				
Duckweed (*Lemna gibba)*	99.6	0.59/0.09 # fronds and growth (meas.)	45919421/Junker/2002	Core
Nonvascular Plants				
Blue-green algae *(Anabaena flos-aqua)*	99.6	1.5/5.0 cell density (meas.)	45919422/Kubitza/2002	Supplemental
Green algae *(Pseudokirchneriella subcapitata = Selenastrum capricornutum)*	99	0.28/0.207 biomass (meas.)	45919416/Kubitza/1998	Supplemental

Algae *Scenedesmus subspicatus*	95.7	0.254 cell density (nominal)	44588903/van Dijk/1990	Supplemental

The guideline is satisfied for *Lemna*. Core studies are needed for the remaining four species.

e. Toxicity to Non-target Insects

An acute contact study with the honey bee (141-1) is required, since the proposed uses are outdoors. Data are summarized in the following table.

Table 11: Toxicity of metam-sodium to Non-target Insects

Species/ Study Duration	% ai	Results/Endpoints Include	MRID/ No. Author/Year	Study Classification[1]
Honey bee	Tech.		00018842/Atkins, et. al./1969	
Acute contact		LD50 = 36.26 ug/bee (practically non-toxic)		Core

The above data indicate that metam-sodium is practically non-toxic to adult bees. The requirement for an acute contact LD50 is satisfied.

APPENDIX II

Structure of Metam Sodium and its Selected Degradates

S
5
$CH_3)NH)C)S^{s}Na^{r}$
Metam Sodium

$CH_3)NH4C4S$
MITC

O
5
$CH_3)NH)C)NH)CH_3$
1,3-Dimethylurea (DMU)

S
5
$CH_3)NH)C)NH)CH_3$
1,3-Dimethylurea (DMTU)

$CH_3)NH_2$
methylamine

$CH_3NHCH{=}S$
N-methylthioformamide

S
5
$CH_3)NH)C)SS^{s}Na^{r}$
Methyl Carbamothioate (MCDT)

APPENDIX III

DRINKING WATER MEMORANDUM

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF PREVENTION, PESTICIDES AND TOXIC SUBSTANCES

September 16, 2003

PC Code 039003
DP Barcode: D293341

MEMORANDUM

SUBJECT: Estimated Drinking Water Concentrations for Metam Sodium and its Metabolite Methyl isothiocyanate for Application on Florida Tomato

To: Veronique LaCapra,
Chemical Review Manger
Special Review and Reregistration Division (7508C)

Carol Christensen
Health Effects Division (7509C)

From: Faruque Khan, Ph.D, Environmental Scientist
Environmental Risk Branch V
Environmental Fate and Effects Division (7507C)

Through: Mah Shamim, Ph.D., Chief
Environmental Risk Branch V
Environmental Fate and Effects Division (7507C)

This memo presents a Tier II Estimated Drinking Water Concentrations (EDWCs) for metam sodium (sodium *N*-methyldithiocarbamate, an active ingredient for fumigants) and its metabolite methyl isothiocyanate (MITC), based on a maximum application rate of 320 lbs. a.i./Acre. The models, PRZM/EXAMS and SCIGROW were used in estimating EDWCs in surface water and groundwater, respectively. The acute concentrations in surface water are 0.03 µg/L for metam sodium and 73.22 µg/L for MITC. The cancer chronic concentrations are 2.99 µg/L for MITC and negligible (≤0.001 µg/L) for metam sodium using the Florida tomato scenario. These values represent the mean value over a 30-year period. Several other scenarios (onion, strawberry, and turf) were also investigated but gave consistently lower EDWCs (results not reported here). The SCIGROW generated EDWCs for tomato 0.13 µg/L for metam sodium and 0.72 µg/L for MITC, which are recommended to use for both acute and chronic exposures. The results are presented in Table 1.

Table 1. Estimated Drinking Water Concentrations (EDWC's) in surface water and Groundwater

Chemical	Surface Water (µg/L)			Groundwater (µg/L)
	Acute	Non-cancer chronic	cancer chronic	
Florida Tomato				
Metam Sodium	0.03	0	0	0.13*
MITC	73.22	0.53	2.99	0.72*

* Recommended EDWCs values for acute and chronic for groundwater

1.0 ESTIMATION OF SURFACE WATER AND GROUNDWATER EXPOSURE CONCENTRATIONS

The maximum application rates and relevant environmental fate parameters for metam sodium and MITC were used in the two screening models PRZM/EXAMS and SCIGROW for EDWCs in surface water and groundwater, respectively. In absence of environmental fate data of MITC, EFED used selected environmental fate data from open literature to estimate EDWCs. Since MITC is a volatile compound, additional input parameters like DAIR (vapor phase diffusion coefficient) and ENPY (enthalpy of vaporization) were activated during the PRZM-EXAMS simulation. The outputs of the two screening models represent estimates of the concentrations that might be found in surface water and groundwater due to the use of metam sodium on Florida tomato.

2.0 Background Information on PRZM/EXAMS

The linked PRZM (3.12) and EXAMS (2.98.5) models (PRZM/EXAMS) are typically used by EFED in estimating pesticides concentrations in surface waters. PRZM is employed to evaluate runoff loading to a receiving surface water body. As soon as the pesticide residues reaches the surface water, EXAMS uses algorithms to the pesticides concentrations by taking into account different dissipation mechanism in the aqueous and sediment phases.

PRZM (3.12)is a one-dimensional finite-difference modeling system that was originally developed to model nitrogen soil kinetic processes and groundwater environment. It was later enhanced to expand its capability to predict pesticides transport and transformation down through the crop zone and saturated zone. The expanded capabilities cover additional phenomena such as soil temperature simulation, microbial transformation, vapor phase transport in soils, volatilization, irrigation simulation, and a method of characteristics (MOC) algorithm to eliminate numerical dispersion. The model can also simulate the fate of two parent and two daughter products and often used in evaluating leaching and runoff.

EXAMS (2.98.5) is a model that has a set of process modules that link fundamental chemical properties to limnological processes that control the kinetics and transport of chemicals in aquatic systems. It provides facilities for steady state or long-term evaluation of chronic chemical discharges, initial-value approaches for studying short-term contaminant releases, and full kinetic simulations that allow for monthly variation in mean climatological factors, and changes in contaminant loadings on daily time scales. It is fairly and relatively complex model that requires more input variables, ranging from hydro-geological and weather data to pesticide physicochemical properties, mobility coefficients, and degradation rate constants in the aqueous and sediment phases.

3.0 Background Information on SCI-GROW

SCIGROW is a regression-based model that provides a groundwater screening exposure value to be used in determining the potential risk to human health from drinking water contaminated with the pesticide. Since the SCI-GROW concentrations are likely to be approached in only very small percentage of drinking water sources (i.e. highly vulnerable aquifers), it is not appropriate to use SCI- GROW for national or regional exposure estimates.

SCIGROW estimates likely groundwater concentrations if the pesticide is used at the maximum allowable rate in areas where groundwater is exceptionally vulnerable to contamination. In most cases, a large majority of the use area will have groundwater that is less vulnerable to contamination than the areas used to derive the SCIGROW estimate.

4.0 Modeling: Inputs and Results

Tables 2and 3 summarize the metam sodium input values used in the model runs for PRZM (3.12), EXAMS 2.98.5) and SCIGROW, respectively. Tables 4 and 5 summarize theMITC input values used in the model runs for PRZM (3.12), EXAMS 2.98.5) and SCIGROW, respectively. Application information is included in Table 2 and 4. Modeling results are presented in Table 1 for PRZM (3.12)/EXAMS (2.98.5) and SCIGROW. This memo also contains the copies of the printouts generated from the PRZM/EXAMS, SCIGROW, and EPISUITE runs.

Table 2. PRZM/EXAM Input Parameters for Metam Sodium

Parameters	Values & Units	Sources
Molecular Weight	129.2 g $Mole^{-1}$	Product Chemistry
Vapor Pressure 25°C	Non volatile	Agrochemical Handbook
Water Solubility @ pH 7.0 and 25°C	722g L^{-1}	Agrochemical Handbook
Hydrolysis Half-Life (pH 5)	2.0 Days	MRID 41631101
Hydrolysis Half-Life (pH 7)	2.0 Days	MRID 41631101
Hydrolysis Half-Life (pH 9)	9.0 Days	MRID 41631101

Table 2. PRZM/EXAM Input Parameters for Metam Sodium

Parameters	Values & Units	Sources
Aerobic Soil Metabolism $t_{½}$,	0.06 Days *	MRID 40198502
Aerobic Aquatic metabolism: for entire sediment/water system	0.12 * *	EFED Guideline
Aqueous Photolysis	0.02 Day	MRID 41517701
Soil Water Partition Coefficient	4.038 L Kg^{-1}	EPISUITE***
Pesticide is Wetted-In	No	Product Label
Crop Management-Tomato		
Pesticide Frequency & application rates (lb a.i./A)	320	Registrant Provided
First Application Date	37725	USDA Crop Profile
Application interval	None	Registrant Provided
Application Method	Ground Injection	Registrant Provided
Spray Efficiency	100%	EFED
Spray Drift (Index Res. Scenario)	None	EFED

* = Due to one reported half-life, input half-life was multiplied by 3 according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides. Version II. December 4, 2001.

**= In absence of aerobic aquatic metabolism half-life, the reported half-lives of aerobic soil metabolism multiplied by 2 according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides. Version II. December 4, 2001.

*** = The EPI (Estimation Program Interface) SuiteTM is a Windows® based suite of physical/chemical property and environmental fate estimation models developed by the EPA's Office of Pollution Prevention Toxics and Syracuse Research Corporation SRC. http://www.epa.gov/opptintr/exposure/docs/updates_episuite_v3.11.htm

Table 3. Environmental Fate Input Parameters for Metam Sodium in SCIGROW.

Parameter	Values & Units	Reference
Organic carbon partition coefficient (K_{OC})	4.038 mL/g	EPISUITE*
Aerobic soil metabolism half-life (days)	0.06 Days	MRID 40198502

* = The EPI (Estimation Program Interface) SuiteTM is a Windows® based suite of physical/chemical property and environmental fate estimation models developed by the EPA's Office of Pollution Prevention Toxics and Syracuse Research Corporation SRC. http://www.epa.gov/opptintr/exposure/docs/updates_episuite_v3.11.htm

Table 4. PRZM/EXAM Input Parameters for MITC, a metam sodium Metabolite

Parameters	Values & Units	Sources
Molecular Weight	73.12g $Mole^{-1}$	Product Chemistry
Vapor Pressure 25°C	19 mm Hg	CDPR, 2002
Water Solubility @ pH 7.0 and 25°C	7600 mg L^{-1}	Product Chemistry
Vapor Phase Diffusion Coefficient (DAIR)	4300 cm^2 day^{-1} (Default)	Carsel et al., 1997
Enthalpy of Vaporization	20 kcal $mole^{-1}$ (Default)	Carsel et al., 1997
Hydrolysis Half-Life (pH 7)	20.4	CDPR, 2002
Aerobic Soil Metabolism $t_{½}$,	6.01 Days (mean value)	Gerstl et at., 1977
Aerobic Aquatic metabolism: for entire sediment/water system	12.02†	EFED Guideline
Anaerobic aquatic metabolism	Stable	MRID 439084-26
Aqueous Photolysis	51.6 Day	CDPR, 2002
Soil Water Partition Coefficient	0.26 L Kg^{-1} (Mean K_d)	Gerstl et at., 1977

Crop Management- Florida Tomato

Pesticide application frequency and rate	150.3 (lb a.i./A)‡	Estimated
Application Date	April 15	Registrant Provided
Application Method	Ground	EFED Guideline
Spray Efficiency	100%	EFED Guideline

† = In absence of aerobic aquatic half-life, the reported half-lives of aerobic soil metabolism multiplied by 2 according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides. Version II. December 4, 2001.

‡ = Metam sodium application rate x [(0.83, the maximum conversion rate from the degradation of metam sodium to MITC in the hydrolysis study) x (0.57, the molecular weight ratio of MITC to metam Sodium]

Table 5. Environmental Fate Input Parameters for MITC in SCIGROW.

Parameter	*Value*	*Reference*
Organic carbon partition coefficient (K_{OC})	14.86 (Median value)	Table 6.
Aerobic soil metabolism half-life (days)	4.8 (Median value)	Gerstl et at., 1977

Table 6. Estimation of Koc‡

Soil	Organic matter (%)	Orgaic Carbon (%)	Kd (mL/g)	Koc (mL/g)
Mivtachim	0.45	0.26	0.012	4.60
Gilat	0.5	29	0.045	15.52

Golan	4.98	2.89	0.41	14.19
Har Baroan	4.1	2.38	0.57	23.97
Median Value				14.86

‡ Gerstl et al., 1977

PRZM/EXAMS Model Output for Metam Sodium on Florida Tomato

Chemical: MetamSodium
PRZM environment: FLtomatoC.txt
EXAMS environment: ir298.exv
Metfile: w12844.dvf

Water segment concentrations (ppb)						
Year	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
1961	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00
1964	0.04	0.01	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00
1971	0.00	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00	0.00
1985	2.06	0.26	0.05	0.02	0.01	0.00
1986	0.00	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	13.55	1.70	0.32	0.11	0.08	0.02
1990	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
0.03	13.55	1.70	0.32	0.11	0.08	0.02

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.06	2.06	0.26	0.05	0.02	0.01	0.00
0.10	0.04	0.01	0.00	0.00	0.00	0.00
0.13	0.00	0.00	0.00	0.00	0.00	0.00
0.16	0.00	0.00	0.00	0.00	0.00	0.00
0.19	0.00	0.00	0.00	0.00	0.00	0.00
0.23	0.00	0.00	0.00	0.00	0.00	0.00
0.26	0.00	0.00	0.00	0.00	0.00	0.00
0.29	0.00	0.00	0.00	0.00	0.00	0.00
0.32	0.00	0.00	0.00	0.00	0.00	0.00
0.35	0.00	0.00	0.00	0.00	0.00	0.00
0.39	0.00	0.00	0.00	0.00	0.00	0.00
0.42	0.00	0.00	0.00	0.00	0.00	0.00
0.45	0.00	0.00	0.00	0.00	0.00	0.00
0.48	0.00	0.00	0.00	0.00	0.00	0.00
0.52	0.00	0.00	0.00	0.00	0.00	0.00
0.55	0.00	0.00	0.00	0.00	0.00	0.00
0.58	0.00	0.00	0.00	0.00	0.00	0.00
0.61	0.00	0.00	0.00	0.00	0.00	0.00
0.65	0.00	0.00	0.00	0.00	0.00	0.00
0.68	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.00	0.00	0.00	0.00	0.00	0.00
0.74	0.00	0.00	0.00	0.00	0.00	0.00
0.77	0.00	0.00	0.00	0.00	0.00	0.00
0.81	0.00	0.00	0.00	0.00	0.00	0.00
0.84	0.00	0.00	0.00	0.00	0.00	0.00
0.87	0.00	0.00	0.00	0.00	0.00	0.00
0.90	0.00	0.00	0.00	0.00	0.00	0.00
0.94	0.00	0.00	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.1	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
						Average of yearly averages:0.00

Estimated Drinking Water Concentration (EDWC)

Acute EEC = (1/10 peak value)(percent crop area)
(0.04 :g/L)(0.87) = 0.03 :g/L

Non-cancer Chronic EEC =(1/10 yearly value)(percent area area)
0.00 :g/L

Cancer chronic EEC = (Mean of annual value)(percent crop area)
0.00 :g/L

PRZM/EXAMS Model Output for MITC on Florida Tomato

Chemical: MITC
PRZM environment: FLtomatoC.txt
EXAMS environment: ir298.exv
Metfile: w12844.dvf

Water segment concentrations (ppb)						
Year	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
1961	0.03	0.02	0.01	0.00	0.00	0.00
1962	0.79	0.46	0.12	0.04	0.03	0.01
1963	2.97	1.50	0.35	0.12	0.08	0.02
1964	84.34	39.73	10.48	3.71	2.48	0.61
1965	0.02	0.01	0.00	0.00	0.00	0.00
1966	0.14	0.07	0.02	0.01	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.11	0.06	0.03	0.01	0.01	0.00
1969	1.50	0.80	0.19	0.07	0.04	0.01
1970	0.03	0.01	0.00	0.00	0.00	0.00
1971	0.81	0.39	0.13	0.05	0.03	0.01
1972	82.58	40.54	9.99	3.52	2.35	0.58
1973	0.58	0.28	0.07	0.02	0.02	0.00
1974	0.02	0.01	0.00	0.00	0.00	0.00
1975	0.03	0.02	0.01	0.00	0.00	0.00
1976	0.30	0.19	0.06	0.02	0.02	0.00
1977	3.52	1.65	0.41	0.15	0.10	0.02
1978	3.07	1.52	0.40	0.14	0.09	0.02
1979	28.49	13.54	3.39	1.19	0.79	0.20
1980	25.71	12.90	3.07	1.08	0.72	0.18
1981	0.13	0.06	0.02	0.01	0.00	0.00
1982	13.26	7.43	1.87	0.65	0.44	0.11
1983	0.01	0.01	0.00	0.00	0.00	0.00
1984	0.04	0.02	0.01	0.00	0.00	0.00
1985	3450.00	1720.00	408.00	143.00	95.28	23.49
1986	0.03	0.02	0.00	0.00	0.00	0.00
1987	0.43	0.20	0.08	0.03	0.02	0.00
1988	2.84	1.40	0.33	0.12	0.08	0.02
1989	11600.00	5780.00	1350.00	473.00	315.00	77.79
1990	4.24	2.04	0.48	0.17	0.11	0.03

Sorted results

Prob.	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
0.03	11600.00	5780.00	1350.00	473.00	315.00	77.79
0.06	3450.00	1720.00	408.00	143.00	95.28	23.49
0.10	84.34	40.54	10.48	3.71	2.48	0.61
0.13	82.58	39.73	9.99	3.52	2.35	0.58
0.16	28.49	13.54	3.39	1.19	0.79	0.20
0.19	25.71	12.90	3.07	1.08	0.72	0.18
0.23	13.26	7.43	1.87	0.65	0.44	0.11
0.26	4.24	2.04	0.48	0.17	0.11	0.03
0.29	3.52	1.65	0.41	0.15	0.10	0.02
0.32	3.07	1.52	0.40	0.14	0.09	0.02

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.35	2.97	1.50	0.35	0.12	0.08	0.02
0.39	2.84	1.40	0.33	0.12	0.08	0.02
0.42	1.50	0.80	0.19	0.07	0.04	0.01
0.45	0.81	0.46	0.13	0.05	0.03	0.01
0.48	0.79	0.39	0.12	0.04	0.03	0.01
0.52	0.58	0.28	0.08	0.03	0.02	0.00
0.55	0.43	0.20	0.07	0.02	0.02	0.00
0.58	0.30	0.19	0.06	0.02	0.02	0.00
0.61	0.14	0.07	0.03	0.01	0.01	0.00
0.65	0.13	0.06	0.02	0.01	0.00	0.00
0.68	0.11	0.06	0.02	0.01	0.00	0.00
0.71	0.04	0.02	0.01	0.00	0.00	0.00
0.74	0.03	0.02	0.01	0.00	0.00	0.00
0.77	0.03	0.02	0.01	0.00	0.00	0.00
0.81	0.03	0.02	0.00	0.00	0.00	0.00
0.84	0.03	0.01	0.00	0.00	0.00	0.00
0.87	0.02	0.01	0.00	0.00	0.00	0.00
0.90	0.02	0.01	0.00	0.00	0.00	0.00
0.94	0.01	0.01	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	**84.16**	**40.46**	**10.43**	**3.69**	**2.46**	**0.61**
Average of yearly averages:3.44						

Estimated Drinking Water Concentration (EDWC)

Acute EEC = (1/10 peak value)(percent crop area)
(84.16 :g/L)(0.87) = 73.22 :g/L

Non-cancer Chronic EEC =(1/10 yearly value)(percent area area)
(0.61 :g/L)(0.87) = 0.53 :g/L

Cancer chronic EEC = (Mean of annual value)(percent crop area)
(3.44 :g/L)(0.87) = 2.99 :g/L

SCIGROW Model Output for Metam Sodium on Florida Tomato

SCIGROW
VERSION 2.3
ENVIRONMENTAL FATE AND EFFECTS DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY
SCREENING MODEL FOR AQUATIC PESTICIDE EXPOSURE

SciGrow version 2.3
chemical:Metam Sodium
time is 9/10/2003 12: 5: 0

Application rate (lb/acre)	Number of applications	Total Use (lb/acre/yr)	Koc (ml/g)	Soil Aerobic metabolism (days)
320.000	1.0	320.000	4.04E+00	0.1

groundwater screening cond (ppb) = 1.25E-01
****

SCIGROW Model Output for MITC on Florida Tomato

SCIGROW
VERSION 2.3
ENVIRONMENTAL FATE AND EFFECTS DIVISION
OFFICE OF PESTICIDE PROGRAMS
U.S. ENVIRONMENTAL PROTECTION AGENCY
SCREENING MODEL FOR AQUATIC PESTICIDE EXPOSURE
SciGrow version 2.3
chemical:MITC
time is 9/16/2003 8:28:11

Application rate (lb/acre)	Number of applications	Total Use (lb/acre/yr)	Koc (ml/g)	Soil Aerobic metabolism (days)
150.300	1.0	150.300	1.49E+01	4.8

groundwater screening cond (ppb) = 7.23E-01
****

EPISUITE OUTPUTS

SMILES : CNC(=S)S[Na]
CHEM : Metham sodium
CAS NUM: 000137-42-8
MOL FOR: C2 H4 N1 S2 Na1
MOL WT : 129.17

------------------------------ EPI SUMMARY (v3.10) --------------------------

Physical Property Inputs:
Water Solubility (mg/L): ------
Vapor Pressure (mm Hg) : ------
Henry LC (atm-m3/mole) : ------
Log Kow (octanol-water): ------
Boiling Point (deg C) : ------
Melting Point (deg C) : ------

Log Octanol-Water Partition Coef (SRC):
Log Kow (KOWWIN v1.66 estimate) = -2.62

Boiling Pt, Melting Pt, Vapor Pressure Estimations (MPBPWIN v1.40):
Boiling Pt (deg C): 460.40 (Adapted Stein & Brown method)
Melting Pt (deg C): 194.10 (Mean or Weighted MP)
VP(mm Hg,25 deg C): 4.53E-009 (Modified Grain method)

Water Solubility Estimate from Log Kow (WSKOW v1.40):
Water Solubility at 25 deg C (mg/L): 1e+006
log Kow used: -2.62 (estimated)
no-melting pt equation used
Water Sol (Exper. database match) = 7.22e+005 mg/L (20 deg C)
Exper. Ref: SHIU,WY ET AL. (1990)

ECOSAR Class Program (ECOSAR v0.99g):
Class(es) found:
Neutral Organics

Henrys Law Constant (25 deg C) [HENRYWIN v3.10]:
Bond Method : Incomplete
Group Method: Incomplete
Henrys LC [VP/WSol estimate using EPI values]: 7.699E-016 atm-m3/mole

Probability of Rapid Biodegradation (BIOWIN v4.00):
Linear Model : 0.6861
Non-Linear Model : 0.7640
Expert Survey Biodegradation Results:
Ultimate Survey Model: 2.9137 (weeks)
Primary Survey Model : 3.6614 (days-weeks)
Readily Biodegradable Probability (MITI Model):
Linear Model : 0.3283
Non-Linear Model : 0.2343

Atmospheric Oxidation (25 deg C) [AopWin v1.90]:

Hydroxyl Radicals Reaction:
OVERALL OH Rate Constant = 64.2648 E-12 cm3/molecule-sec
Half-Life = 0.166 Days (12-hr day; 1.5E6 OH/cm3)
Half-Life = 1.997 Hrs
Ozone Reaction:
No Ozone Reaction Estimation

Soil Adsorption Coefficient (PCKOCWIN v1.66):
Koc : 4.038
Log Koc: 0.606

Aqueous Base/Acid-Catalyzed Hydrolysis (25 deg C) [HYDROWIN v1.67]:
Rate constants can NOT be estimated for this structure!

BCF Estimate from Log Kow (BCFWIN v2.14):
Log BCF = 0.500 (BCF = 3.162)
log Kow used: 0.48 (estimated)

Volatilization from Water:
Henry LC: 7.7E-016 atm-m3/mole (calculated from VP/WS)
Half-Life from Model River: 8.643E+011 hours (3.601E+010 days)
Half-Life from Model Lake : 9.428E+012 hours (3.928E+011 days)

Removal In Wastewater Treatment:
Total removal: 1.85 percent
Total biodegradation: 0.09 percent
Total sludge adsorption: 1.75 percent
Total to Air: 0.00 percent

Level III Fugacity Model:

	Mass Amount (percent)	Half-Life (hr)	Emissions (kg/hr)
Air	1.3e-007	3.99	1000
Water	45.3	360	1000
Soil	54.6	360	1000
Sediment	0.0755	1.44e+003	0

Persistence Time: 421 hr

SMILES : N(=C=S)C
CHEM : Methane, isothiocyanato-
CAS NUM: 000556-61-6
MOL FOR: C2 H3 N1 S1
MOL WT : 73.11
------------------------------ EPI SUMMARY (v3.10) --------------------------
Physical Property Inputs:
Water Solubility (mg/L): ------
Vapor Pressure (mm Hg) : ------

Henry LC (atm-m3/mole) :   ------
Log Kow (octanol-water):   ------
Boiling Point (deg C) :   ------
Melting Point (deg C) :   ------

Log Octanol-Water Partition Coef (SRC):
Log Kow (KOWWIN v1.66 estimate) = 1.30
Log Kow (Exper. database match) = 0.94
Exper. Ref: Pomona (1987)

Boiling Pt, Melting Pt, Vapor Pressure Estimations (MPBPWIN v1.40):
Boiling Pt (deg C): 90.58 (Adapted Stein & Brown method)
Melting Pt (deg C): -63.26 (Mean or Weighted MP)
VP(mm Hg,25 deg C): 12.2 (Modified Grain method)
MP (exp database): 36 deg C
BP (exp database): 119 deg C
VP (exp database): 3.54E+00 mm Hg at 25 deg C

Water Solubility Estimate from Log Kow (WSKOW v1.40):
Water Solubility at 25 deg C (mg/L): 2.113e+004
log Kow used: 0.94 (expkow database)
no-melting pt equation used
Water Sol (Exper. database match) = 7600 mg/L (20 deg C)
Exper. Ref: YALKOWSKY,SH & DANNENFELSER,RM (1992)

ECOSAR Class Program (ECOSAR v0.99g):
Class(es) found:
Thiocyanates

Henrys Law Constant (25 deg C) [HENRYWIN v3.10]:
Bond Method :   3.11E-003 atm-m3/mole
Group Method: Incomplete
Exper Database: 4.48E-05 atm-m3/mole
Henrys LC [VP/WSol estimate using EPI values]: 5.554E-005 atm-m3/mole

Probability of Rapid Biodegradation (BIOWIN v4.00):
Linear Model   :   0.7127
Non-Linear Model   :   0.8777
Expert Survey Biodegradation Results:
Ultimate Survey Model: 3.0376 (weeks   )
Primary Survey Model :   3.7423 (days-weeks)
Readily Biodegradable Probability (MITI Model):
Linear Model   :   0.4950
Non-Linear Model   :   0.6069

Atmospheric Oxidation (25 deg C) [AopWin v1.90]:
Hydroxyl Radicals Reaction:
OVERALL OH Rate Constant =   0.1360 E-12 cm3/molecule-sec
Half-Life =   78.647 Days (12-hr day; 1.5E6 OH/cm3)
Ozone Reaction:
No Ozone Reaction Estimation

Soil Adsorption Coefficient (PCKOCWIN v1.66):
Koc : 3.477
Log Koc: 0.541

Aqueous Base/Acid-Catalyzed Hydrolysis (25 deg C) [HYDROWIN v1.67]:
Rate constants can NOT be estimated for this structure!

BCF Estimate from Log Kow (BCFWIN v2.14):
Log BCF = 0.500 (BCF = 3.162)
log Kow used: 0.94 (expkow database)

Volatilization from Water:
Henry LC: 4.48E-005 atm-m3/mole (Henry experimental database)
Half-Life from Model River: 12.05 hours
Half-Life from Model Lake : 203.1 hours (8.463 days)

Removal In Wastewater Treatment:
Total removal: 4.20 percent
Total biodegradation: 0.09 percent
Total sludge adsorption: 1.75 percent
Total to Air: 2.36 percent

Level III Fugacity Model:

	Mass Amount (percent)	Half-Life (hr)	Emissions (kg/hr)
Air	15	1.89e+003	1000
Water	46.2	360	1000
Soil	38.7	360	1000
Sediment	0.0828	1.44e+003	0

Persistence Time: 274 hr

REFERENCES

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Carsel, R.F., J.C.,Imhoff, P.R. Hummel, J.M. Cheplick, and J.S. Donigian, Jr. 1997. PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.0; Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

CDPR (California Dept. of Pesticide Regulation). 2002. Evaluation of Methyl Isothiocyanate as a Toxic Air Contaminant, Part A-Environmental Fate. California Environmental Protection Agency, Sacramento, CA.

EPISUITE. The EPI (Estimation Program Interface) SuiteTM is a Windows® based suite of physical/chemical property and environmental fate estimation models developed by the EPA's Office of Pollution Prevention Toxics and Syracuse Research Corporation SRC. http://www.epa.gov/opptintr/exposure/docs/updates_episuite_v3.11.htm

Gerstl, Z., U. Minglgrin, and B Yaron. 1977. Behavior of Vapam and Methylisothiocyanate in Soil. Soil Sci. Soc. Am. J. 41:545-548.

APPENDIX IV

Modeling Inputs/Outputs for Ecological Risk Assessment

The maximum application rate and relevant environmental fate parameters for Metam Sodium were used in the two screening models PRZM/EXAMS and SCIGROW for Metam Sodium concentrations in surface water and groundwater, respectively. The outputs of the two screening models represent estimates of the concentrations that might be found in surface water and groundwater due to the use of Metam Sodium on selected crops.

Estimation of surface water exposure concentrations for Ecological Risk Assessment

The maximum application rate and relevant environmental fate parameters for Metam Sodium were used in the PRZM/EXAMS Tier II model for EECs in the surface water. The output of the screening model represent an upper-bound estimate of the concentrations of Metam Sodium that might be found in surface water due to use of Metam Sodium on selected crops. The weather, agricultural practices, and Metam Sodium applications were simulated over 30 years so that the ten year excedence probability at the site could be estimated. The EECs generated in this analysis were estimated using PRZM 3.12 (Pesticide Root Zone Model) for simulating runoff and erosion from the agricultural field and EXAMS 2.98.5 (Exposure Analysis Modeling System) for estimating environmental fate and transport in surface water. Table A-1 summarizes the input values used in the selected crops and models run for PRZM/EXAMS.

(1) PRZM/EXAMS Model Input for Ecological Risk Assessment

Table 1A. PRZM/EXAM Input Parameters for Metam Sodium

Parameters	Values & Units	Sources
Molecular Weight	129.2 g $Mole^{-1}$	Product Chemistry
Vapor Pressure 25°C	Non volatile	Agrochemical Handbook
Water Solubility @ pH 7.0 and 20°C	722g L^{-1}	Agrochemical Handbook
Hydrolysis Half-Life (pH 5)	2.0 Days	MRID 41631101
Hydrolysis Half-Life (pH 7)	2.0 Days	MRID 41631101
Hydrolysis Half-Life (pH 9)	9.0 Days	MRID 41631101
Aerobic Soil Metabolism $t_{½}$,	0.06 Days *	MRID 40198502
Aerobic Aquatic metabolism: for entire sediment/water system	0.12 * *	EFED Guideline
Aqueous Photolysis	0.02 Day	MRID 41517701
Soil Water Partition Coefficient	4.038 L Kg^{-1}	EPISUITE***

Table 1A. PRZM/EXAM Input Parameters for Metam Sodium

Parameters	Values & Units	Sources
Pesticide is Wetted-In	No	Product Label
Crop Management		
Pesticide Frequency & application rates (lb a.i./A)	320.0	Registrant Provided
Application Date for California Onion	February 15	USDA Crop Profiles
Application Date for Florida Tomato	April 15	USDA Crop Profiles
Application Date for Idaho Potato	April 15	USDA Crop Profiles
Application Date for Pennsylvania Turf	April 15	USDA Crop Profiles
Application interval	None	Registrant Provided
Application Method	Ground Application	Registrant Provided
Spray Efficiency	100%	EFED
Spray Drift (Index Res. Scenario)	None	EFED

* = Due to one reported half-life, input half-life was multiplied by 3 according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides. Version II. December 4, 2001.

**= In absence of aerobic aquatic metabolism half-life, the reported half-lives of aerobic soil metabolism multiplied by 2 according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides. Version II. December 4, 2001.

*** = The EPI (Estimation Program Interface) SuiteTM is a Windows® based suite of physical/chemical property and environmental fate estimation models developed by the EPA's Office of Pollution Prevention Toxics and Syracuse Research Corporation SRC. http://www.epa.gov/opptintr/exposure/docs/updates_episuite_v3.11.htm

Table 1B. PRZM/EXAM Input Parameters for MITC, a metam sodium Metabolite

Parameters	Values & Units	Sources
Molecular Weight	73.12g $Mole^{-1}$	Product Chemistry
Vapor Pressure 25^{o}C	19 mm Hg	CDPR, 2002
Water Solubility @ pH 7.0 and 25^{o}C	7600 mg L^{-1}	Product Chemistry
Vapor Phase Diffusion Coefficient (DAIR)	4300 cm^2 day^{-1} (Default)	Carsel et al., 1997
Enthalpy of Vaporization	20 kcal $mole^{-1}$ (Default)	Carsel et al., 1997
Hydrolysis Half-Life (pH 7)	20.4	CDPR, 2002
Aerobic Soil Metabolism $t_{½}$,	6.01 Days (mean value)	Gerstl et at., 1977
Aerobic Aquatic metabolism: for entire sediment/water system	12.02†	EFED Guideline
Anaerobic aquatic metabolism	Stable	MRID 439084-26

Table 1B. PRZM/EXAM Input Parameters for MITC, a metam sodium Metabolite

Parameters	Values & Units	Sources
Aqueous Photolysis	51.6 Day	CDPR, 2002
Soil Water Partition Coefficient	0.26 L Kg^{-1} (Mean K_d)	Gerstl et at., 1977
	Crop Management	
Pesticide application frequency and rate	150.3 (lb a.i./A)‡	Estimated
Application Date California Onion	February 15	USDA Crop Profiles
Application Date Florida Tomato	April 15	USDA Crop Profiles
Application Date Idaho Potato	April 15	USDA Crop Profiles
Application Date for Pennsylvania Turf	April 15	USDA Crop Profiles
Application Method	Ground Application	EFED Guideline
Spray Efficiency	100%	EFED Guideline

† = In absence of aerobic aquatic half-life, the reported half-lives of aerobic soil metabolism multiplied by 2 according to Guidance for selecting input parameters in modeling for environmental fate and transport of pesticides. Version II. December 4, 2001.

‡ = Metam sodium application rate x [(0.83, the maximum conversion rate from the degradation of metam sodium to MITC in the hydrolysis study) x (0.57, the molecular weight ratio of MITC to metam Sodium]

(II) PRZM/EXAMS Model Output for Ecological Risk Water Assessment

Chemical: MetamSodium
PRZM environment: CAonionC.txt
EXAMS environment: pond298.exv
Metfile: w23155.dvf

Water segment concentrations (ppb)						
Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00
1964	0.00	0.00	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00
1971	0.00	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00	0.00

Chemical: MetamSodium
PRZM environment: CAonionC.txt
EXAMS environment: pond298.exv
Metfile: w23155.dvf

Water segment concentrations (ppb)						
1978	0.00	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00	0.00	0.00
1986	0.00	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	0.00
1990	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.03	0.00	0.00	0.00	0.00	0.00	0.00
0.06	0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.00	0.00	0.00	0.00	0.00	0.00
0.13	0.00	0.00	0.00	0.00	0.00	0.00
0.16	0.00	0.00	0.00	0.00	0.00	0.00
0.19	0.00	0.00	0.00	0.00	0.00	0.00
0.23	0.00	0.00	0.00	0.00	0.00	0.00
0.26	0.00	0.00	0.00	0.00	0.00	0.00
0.29	0.00	0.00	0.00	0.00	0.00	0.00
0.32	0.00	0.00	0.00	0.00	0.00	0.00
0.35	0.00	0.00	0.00	0.00	0.00	0.00
0.39	0.00	0.00	0.00	0.00	0.00	0.00
0.42	0.00	0.00	0.00	0.00	0.00	0.00
0.45	0.00	0.00	0.00	0.00	0.00	0.00
0.48	0.00	0.00	0.00	0.00	0.00	0.00
0.52	0.00	0.00	0.00	0.00	0.00	0.00
0.55	0.00	0.00	0.00	0.00	0.00	0.00
0.58	0.00	0.00	0.00	0.00	0.00	0.00
0.61	0.00	0.00	0.00	0.00	0.00	0.00
0.65	0.00	0.00	0.00	0.00	0.00	0.00
0.68	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.00	0.00	0.00	0.00	0.00	0.00
0.74	0.00	0.00	0.00	0.00	0.00	0.00
0.77	0.00	0.00	0.00	0.00	0.00	0.00
0.81	0.00	0.00	0.00	0.00	0.00	0.00
0.84	0.00	0.00	0.00	0.00	0.00	0.00
0.87	0.00	0.00	0.00	0.00	0.00	0.00
0.90	0.00	0.00	0.00	0.00	0.00	0.00
0.94	0.00	0.00	0.00	0.00	0.00	0.00

Chemical: MetamSodium
PRZM environment: CAonionC.txt
EXAMS environment: pond298.exv
Metfile: w23155.dvf

Water segment concentrations (ppb)						
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.00	0.00	0.00	0.00	0.00	0.00
Average of yearly averages:						0.00

Chemical: MITC
PRZM environment: CAonionC.txt
EXAMS environment: pond298.exv
Metfile: w23155.dvf

Water segment concentrations (ppb)						
Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.01	0.01	0.00	0.00	0.00	0.00
1962	90.60	63.19	22.12	7.86	5.24	1.29
1963	0.02	0.01	0.00	0.00	0.00	0.00
1964	0.00	0.00	0.00	0.00	0.00	0.00
1965	51.79	40.52	14.27	5.06	3.37	0.83
1966	0.02	0.01	0.01	0.00	0.00	0.00
1967	0.01	0.01	0.00	0.00	0.00	0.00
1968	0.03	0.02	0.01	0.00	0.00	0.00
1969	0.99	0.71	0.25	0.09	0.06	0.02
1970	0.03	0.03	0.01	0.00	0.00	0.00
1971	0.03	0.02	0.01	0.00	0.00	0.00
1972	0.02	0.01	0.00	0.00	0.00	0.00
1973	0.02	0.01	0.00	0.00	0.00	0.00
1974	0.40	0.27	0.09	0.03	0.02	0.01
1975	0.01	0.01	0.00	0.00	0.00	0.00
1976	0.03	0.02	0.01	0.00	0.00	0.00
1977	0.01	0.00	0.00	0.00	0.00	0.00
1978	0.02	0.01	0.00	0.00	0.00	0.00
1979	0.73	0.51	0.18	0.07	0.04	0.01
1980	11.17	7.69	2.62	0.94	0.63	0.15
1981	0.01	0.00	0.00	0.00	0.00	0.00
1982	0.04	0.03	0.01	0.00	0.00	0.00
1983	0.10	0.07	0.02	0.01	0.01	0.00
1984	0.02	0.01	0.00	0.00	0.00	0.00
1985	2.09	1.46	0.51	0.18	0.12	0.03
1986	0.02	0.02	0.01	0.00	0.00	0.00
1987	0.02	0.01	0.00	0.00	0.00	0.00
1988	0.03	0.02	0.01	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	0.00
1990	3.39	1.96	0.53	0.19	0.12	0.03

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.03	90.60	63.19	22.12	7.86	5.24	1.29
0.06	51.79	40.52	14.27	5.06	3.37	0.83

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.10	11.17	7.69	2.62	0.94	0.63	0.15
0.13	3.39	1.96	0.53	0.19	0.12	0.03
0.16	2.09	1.46	0.51	0.18	0.12	0.03
0.19	0.99	0.71	0.25	0.09	0.06	0.02
0.23	0.73	0.51	0.18	0.07	0.04	0.01
0.26	0.40	0.27	0.09	0.03	0.02	0.01
0.29	0.10	0.07	0.02	0.01	0.01	0.00
0.32	0.04	0.03	0.01	0.00	0.00	0.00
0.35	0.03	0.03	0.01	0.00	0.00	0.00
0.39	0.03	0.02	0.01	0.00	0.00	0.00
0.42	0.03	0.02	0.01	0.00	0.00	0.00
0.45	0.03	0.02	0.01	0.00	0.00	0.00
0.48	0.03	0.02	0.01	0.00	0.00	0.00
0.52	0.02	0.02	0.01	0.00	0.00	0.00
0.55	0.02	0.01	0.01	0.00	0.00	0.00
0.58	0.02	0.01	0.00	0.00	0.00	0.00
0.61	0.02	0.01	0.00	0.00	0.00	0.00
0.65	0.02	0.01	0.00	0.00	0.00	0.00
0.68	0.02	0.01	0.00	0.00	0.00	0.00
0.71	0.02	0.01	0.00	0.00	0.00	0.00
0.74	0.02	0.01	0.00	0.00	0.00	0.00
0.77	0.01	0.01	0.00	0.00	0.00	0.00
0.81	0.01	0.01	0.00	0.00	0.00	0.00
0.84	0.01	0.01	0.00	0.00	0.00	0.00
0.87	0.01	0.00	0.00	0.00	0.00	0.00
0.90	0.01	0.00	0.00	0.00	0.00	0.00
0.94	0.00	0.00	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	10.39	7.12	2.41	0.86	0.58	0.14
Average of yearly averages:						0.08

Chemical: MetamSodium
PRZM environment: FLtomatoC.txt
EXAMS environment: pond298.exv
Metfile: w12844.dvf

Water segment concentrations (ppb)						
Year	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
1961	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00
1964	0.02	0.00	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00
1971	0.00	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00	0.00
1985	0.86	0.11	0.02	0.01	0.00	0.00
1986	0.00	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	5.65	0.71	0.14	0.05	0.03	0.01
1990	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.03	5.65	0.71	0.14	0.05	0.03	0.01
0.06	0.86	0.11	0.02	0.01	0.00	0.00
0.10	0.02	0.00	0.00	0.00	0.00	0.00
0.13	0.00	0.00	0.00	0.00	0.00	0.00
0.16	0.00	0.00	0.00	0.00	0.00	0.00
0.19	0.00	0.00	0.00	0.00	0.00	0.00
0.23	0.00	0.00	0.00	0.00	0.00	0.00
0.26	0.00	0.00	0.00	0.00	0.00	0.00
0.29	0.00	0.00	0.00	0.00	0.00	0.00
0.32	0.00	0.00	0.00	0.00	0.00	0.00
0.35	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.39	0.00	0.00	0.00	0.00	0.00	0.00
0.42	0.00	0.00	0.00	0.00	0.00	0.00
0.45	0.00	0.00	0.00	0.00	0.00	0.00
0.48	0.00	0.00	0.00	0.00	0.00	0.00
0.52	0.00	0.00	0.00	0.00	0.00	0.00
0.55	0.00	0.00	0.00	0.00	0.00	0.00
0.58	0.00	0.00	0.00	0.00	0.00	0.00
0.61	0.00	0.00	0.00	0.00	0.00	0.00
0.65	0.00	0.00	0.00	0.00	0.00	0.00
0.68	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.00	0.00	0.00	0.00	0.00	0.00
0.74	0.00	0.00	0.00	0.00	0.00	0.00
0.77	0.00	0.00	0.00	0.00	0.00	0.00
0.81	0.00	0.00	0.00	0.00	0.00	0.00
0.84	0.00	0.00	0.00	0.00	0.00	0.00
0.87	0.00	0.00	0.00	0.00	0.00	0.00
0.90	0.00	0.00	0.00	0.00	0.00	0.00
0.94	0.00	0.00	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.02	0.00	0.00	0.00	0.00	0.00
Average of yearly averages:						0.00

Chemical: MITC
PRZM environment: FLtomatoC.txt
EXAMS environment: pond298.exv
Metfile: w12844.dvf

Water segment concentrations (ppb)						
Year	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
1961	0.01	0.01	0.00	0.00	0.00	0.00
1962	0.35	0.22	0.06	0.02	0.02	0.00
1963	1.24	0.73	0.20	0.07	0.05	0.01
1964	35.18	18.43	5.22	1.87	1.25	0.31
1965	0.01	0.00	0.00	0.00	0.00	0.00
1966	0.06	0.03	0.01	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.05	0.03	0.02	0.01	0.00	0.00
1969	0.63	0.38	0.10	0.04	0.02	0.01
1970	0.01	0.01	0.00	0.00	0.00	0.00
1971	0.34	0.19	0.07	0.02	0.02	0.00
1972	34.45	19.71	5.50	1.94	1.30	0.32
1973	0.24	0.14	0.04	0.01	0.01	0.00
1974	0.01	0.01	0.00	0.00	0.00	0.00
1975	0.01	0.01	0.00	0.00	0.00	0.00
1976	0.13	0.09	0.04	0.01	0.01	0.00
1977	1.47	0.77	0.20	0.07	0.05	0.01
1978	1.28	0.74	0.22	0.08	0.05	0.01
1979	12.03	6.36	1.71	0.60	0.40	0.10
1980	10.72	6.29	1.71	0.60	0.40	0.10
1981	0.06	0.03	0.01	0.00	0.00	0.00
1982	5.77	3.55	1.02	0.36	0.24	0.06
1983	0.01	0.00	0.00	0.00	0.00	0.00
1984	0.02	0.01	0.00	0.00	0.00	0.00
1985	1440.00	842.00	228.00	80.02	53.35	13.15
1986	0.01	0.01	0.00	0.00	0.00	0.00
1987	0.18	0.09	0.04	0.01	0.01	0.00
1988	1.19	0.68	0.18	0.07	0.04	0.01
1989	4840.00	2800.00	741.00	260.00	173.00	42.67
1990	1.77	0.98	0.26	0.09	0.06	0.02

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.03	4840.00	2800.00	741.00	260.00	173.00	42.67
0.06	1440.00	842.00	228.00	80.02	53.35	13.15
0.10	35.18	19.71	5.50	1.94	1.30	0.32
0.13	34.45	18.43	5.22	1.87	1.25	0.31
0.16	12.03	6.36	1.71	0.60	0.40	0.10
0.19	10.72	6.29	1.71	0.60	0.40	0.10
0.23	5.77	3.55	1.02	0.36	0.24	0.06
0.26	1.77	0.98	0.26	0.09	0.06	0.02
0.29	1.47	0.77	0.22	0.08	0.05	0.01
0.32	1.28	0.74	0.20	0.07	0.05	0.01

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.35	1.24	0.73	0.20	0.07	0.05	0.01
0.39	1.19	0.68	0.18	0.07	0.04	0.01
0.42	0.63	0.38	0.10	0.04	0.02	0.01
0.45	0.35	0.22	0.07	0.02	0.02	0.00
0.48	0.34	0.19	0.06	0.02	0.02	0.00
0.52	0.24	0.14	0.04	0.01	0.01	0.00
0.55	0.18	0.09	0.04	0.01	0.01	0.00
0.58	0.13	0.09	0.04	0.01	0.01	0.00
0.61	0.06	0.03	0.02	0.01	0.00	0.00
0.65	0.06	0.03	0.01	0.00	0.00	0.00
0.68	0.05	0.03	0.01	0.00	0.00	0.00
0.71	0.02	0.01	0.00	0.00	0.00	0.00
0.74	0.01	0.01	0.00	0.00	0.00	0.00
0.77	0.01	0.01	0.00	0.00	0.00	0.00
0.81	0.01	0.01	0.00	0.00	0.00	0.00
0.84	0.01	0.01	0.00	0.00	0.00	0.00
0.87	0.01	0.01	0.00	0.00	0.00	0.00
0.90	0.01	0.00	0.00	0.00	0.00	0.00
0.94	0.01	0.00	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	35.11	19.58	5.47	1.93	1.29	0.32
				Average of yearly averages:1.89		

Chemical: MetamSodium
PRZM environment: IDpotatoC.txt
EXAMS environment: pond298.exv
Metfile: w24156.dvf

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00
1964	0.00	0.00	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00
1971	0.00	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00	0.00	0.00
1986	0.00	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	0.00
1990	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
0.03	0.00	0.00	0.00	0.00	0.00	0.00
0.06	0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.00	0.00	0.00	0.00	0.00	0.00
0.13	0.00	0.00	0.00	0.00	0.00	0.00
0.16	0.00	0.00	0.00	0.00	0.00	0.00
0.19	0.00	0.00	0.00	0.00	0.00	0.00
0.23	0.00	0.00	0.00	0.00	0.00	0.00
0.26	0.00	0.00	0.00	0.00	0.00	0.00
0.29	0.00	0.00	0.00	0.00	0.00	0.00
0.32	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.35	0.00	0.00	0.00	0.00	0.00	0.00
0.39	0.00	0.00	0.00	0.00	0.00	0.00
0.42	0.00	0.00	0.00	0.00	0.00	0.00
0.45	0.00	0.00	0.00	0.00	0.00	0.00
0.48	0.00	0.00	0.00	0.00	0.00	0.00
0.52	0.00	0.00	0.00	0.00	0.00	0.00
0.55	0.00	0.00	0.00	0.00	0.00	0.00
0.58	0.00	0.00	0.00	0.00	0.00	0.00
0.61	0.00	0.00	0.00	0.00	0.00	0.00
0.65	0.00	0.00	0.00	0.00	0.00	0.00
0.68	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.00	0.00	0.00	0.00	0.00	0.00
0.74	0.00	0.00	0.00	0.00	0.00	0.00
0.77	0.00	0.00	0.00	0.00	0.00	0.00
0.81	0.00	0.00	0.00	0.00	0.00	0.00
0.84	0.00	0.00	0.00	0.00	0.00	0.00
0.87	0.00	0.00	0.00	0.00	0.00	0.00
0.90	0.00	0.00	0.00	0.00	0.00	0.00
0.94	0.00	0.00	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Average of yearly averages:						**0.00**

Chemical: MITC
PRZM environment: IDpotatoC.txt
EXAMS environment: pond298.exv
Metfile: w24156.dvf

Water segment concentrations (ppb)						
Year	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
1961	0.02	0.01	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00
1963	1.59	1.07	0.35	0.13	0.08	0.02
1964	0.24	0.15	0.07	0.02	0.02	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.01	0.01	0.00	0.00	0.00	0.00
1967	0.05	0.03	0.01	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.01	0.01	0.00	0.00	0.00	0.00
1971	1.84	1.27	0.49	0.17	0.12	0.03
1972	0.00	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.01	0.00	0.00	0.00	0.00	0.00
1975	0.05	0.03	0.01	0.00	0.00	0.00
1976	1.09	0.75	0.24	0.09	0.06	0.01
1977	0.01	0.01	0.00	0.00	0.00	0.00
1978	0.01	0.01	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00
1981	0.73	0.46	0.14	0.05	0.03	0.01
1982	0.01	0.01	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00	0.00	0.00
1984	7.49	4.62	1.39	0.49	0.33	0.08
1985	0.00	0.00	0.00	0.00	0.00	0.00
1986	0.02	0.01	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	0.00
1990	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.03	7.49	4.62	1.39	0.49	0.33	0.08
0.06	1.84	1.27	0.49	0.17	0.12	0.03
0.10	1.59	1.07	0.35	0.13	0.08	0.02
0.13	1.09	0.75	0.24	0.09	0.06	0.01
0.16	0.73	0.46	0.14	0.05	0.03	0.01
0.19	0.24	0.15	0.07	0.02	0.02	0.00
0.23	0.05	0.03	0.01	0.00	0.00	0.00
0.26	0.05	0.03	0.01	0.00	0.00	0.00
0.29	0.02	0.01	0.00	0.00	0.00	0.00
0.32	0.02	0.01	0.00	0.00	0.00	0.00
0.35	0.01	0.01	0.00	0.00	0.00	0.00

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.39	0.01	0.01	0.00	0.00	0.00	0.00
0.42	0.01	0.01	0.00	0.00	0.00	0.00
0.45	0.01	0.01	0.00	0.00	0.00	0.00
0.48	0.01	0.01	0.00	0.00	0.00	0.00
0.52	0.01	0.00	0.00	0.00	0.00	0.00
0.55	0.00	0.00	0.00	0.00	0.00	0.00
0.58	0.00	0.00	0.00	0.00	0.00	0.00
0.61	0.00	0.00	0.00	0.00	0.00	0.00
0.65	0.00	0.00	0.00	0.00	0.00	0.00
0.68	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.00	0.00	0.00	0.00	0.00	0.00
0.74	0.00	0.00	0.00	0.00	0.00	0.00
0.77	0.00	0.00	0.00	0.00	0.00	0.00
0.81	0.00	0.00	0.00	0.00	0.00	0.00
0.84	0.00	0.00	0.00	0.00	0.00	0.00
0.87	0.00	0.00	0.00	0.00	0.00	0.00
0.90	0.00	0.00	0.00	0.00	0.00	0.00
0.94	0.00	0.00	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	**1.54**	**1.03**	**0.34**	**0.12**	**0.08**	**0.02**

Average of yearly averages: **0.01**

Chemical: MetamSodium
PRZM environment: PAturfC.txt
EXAMS environment: pond298.exv
Metfile: w14737.dvf

Water segment concentrations (ppb)						
Year	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
1961	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00
1964	0.00	0.00	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00
1971	0.00	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00	0.00	0.00
1983	0.01	0.00	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00	0.00	0.00
1986	0.00	0.00	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	0.00
1990	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.03	0.01	0.00	0.00	0.00	0.00	0.00
0.06	0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.00	0.00	0.00	0.00	0.00	0.00
0.13	0.00	0.00	0.00	0.00	0.00	0.00
0.16	0.00	0.00	0.00	0.00	0.00	0.00
0.19	0.00	0.00	0.00	0.00	0.00	0.00
0.23	0.00	0.00	0.00	0.00	0.00	0.00
0.26	0.00	0.00	0.00	0.00	0.00	0.00
0.29	0.00	0.00	0.00	0.00	0.00	0.00
0.32	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results						
Prob.	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
0.35	0.00	0.00	0.00	0.00	0.00	0.00
0.39	0.00	0.00	0.00	0.00	0.00	0.00
0.42	0.00	0.00	0.00	0.00	0.00	0.00
0.45	0.00	0.00	0.00	0.00	0.00	0.00
0.48	0.00	0.00	0.00	0.00	0.00	0.00
0.52	0.00	0.00	0.00	0.00	0.00	0.00
0.55	0.00	0.00	0.00	0.00	0.00	0.00
0.58	0.00	0.00	0.00	0.00	0.00	0.00
0.61	0.00	0.00	0.00	0.00	0.00	0.00
0.65	0.00	0.00	0.00	0.00	0.00	0.00
0.68	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.00	0.00	0.00	0.00	0.00	0.00
0.74	0.00	0.00	0.00	0.00	0.00	0.00
0.77	0.00	0.00	0.00	0.00	0.00	0.00
0.81	0.00	0.00	0.00	0.00	0.00	0.00
0.84	0.00	0.00	0.00	0.00	0.00	0.00
0.87	0.00	0.00	0.00	0.00	0.00	0.00
0.90	0.00	0.00	0.00	0.00	0.00	0.00
0.94	0.00	0.00	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
		Average of yearly averages:				**0.00**

Chemical: MITC
PRZM environment: PAturfC.txt
EXAMS environment: pond298.exv
Metfile: w14737.dvf

Water segment concentrations (ppb)						
Year	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
1961	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00
1964	1.79	1.21	0.40	0.14	0.09	0.02
1965	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.03	0.02	0.01	0.00	0.00	0.00
1968	0.34	0.23	0.07	0.03	0.02	0.00
1969	0.15	0.10	0.03	0.01	0.01	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00
1971	0.00	0.00	0.00	0.00	0.00	0.00
1972	8.62	5.81	1.89	0.67	0.45	0.11
1973	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00	0.00
1978	0.01	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.01	0.01	0.00	0.00	0.00	0.00
1981	0.05	0.03	0.01	0.00	0.00	0.00
1982	0.01	0.00	0.00	0.00	0.00	0.00
1983	122.00	79.84	26.03	9.17	6.11	1.51
1984	2.25	1.48	0.48	0.17	0.12	0.03
1985	0.07	0.05	0.02	0.01	0.00	0.00
1986	197.00	130.00	39.98	14.06	9.38	2.31
1987	0.00	0.00	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.01	0.01	0.00	0.00	0.00	0.00
1990	0.00	0.00	0.00	0.00	0.00	0.00

Sorted results

Prob.	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
0.03	197.00	130.00	39.98	14.06	9.38	2.31
0.06	122.00	79.84	26.03	9.17	6.11	1.51
0.10	8.62	5.81	1.89	0.67	0.45	0.11
0.13	2.25	1.48	0.48	0.17	0.12	0.03
0.16	1.79	1.21	0.40	0.14	0.09	0.02
0.19	0.34	0.23	0.07	0.03	0.02	0.00
0.23	0.15	0.10	0.03	0.01	0.01	0.00
0.26	0.07	0.05	0.02	0.01	0.00	0.00
0.29	0.05	0.03	0.01	0.00	0.00	0.00
0.32	0.03	0.02	0.01	0.00	0.00	0.00

Sorted results						
Prob.	**Peak**	**96 hr**	**21 Day**	**60 Day**	**90 Day**	**Yearly**
0.35	0.01	0.01	0.00	0.00	0.00	0.00
0.39	0.01	0.01	0.00	0.00	0.00	0.00
0.42	0.01	0.00	0.00	0.00	0.00	0.00
0.45	0.01	0.00	0.00	0.00	0.00	0.00
0.48	0.00	0.00	0.00	0.00	0.00	0.00
0.52	0.00	0.00	0.00	0.00	0.00	0.00
0.55	0.00	0.00	0.00	0.00	0.00	0.00
0.58	0.00	0.00	0.00	0.00	0.00	0.00
0.61	0.00	0.00	0.00	0.00	0.00	0.00
0.65	0.00	0.00	0.00	0.00	0.00	0.00
0.68	0.00	0.00	0.00	0.00	0.00	0.00
0.71	0.00	0.00	0.00	0.00	0.00	0.00
0.74	0.00	0.00	0.00	0.00	0.00	0.00
0.77	0.00	0.00	0.00	0.00	0.00	0.00
0.81	0.00	0.00	0.00	0.00	0.00	0.00
0.84	0.00	0.00	0.00	0.00	0.00	0.00
0.87	0.00	0.00	0.00	0.00	0.00	0.00
0.90	0.00	0.00	0.00	0.00	0.00	0.00
0.94	0.00	0.00	0.00	0.00	0.00	0.00
0.97	0.00	0.00	0.00	0.00	0.00	0.00
0.10	**7.98**	**5.37**	**1.75**	**0.62**	**0.41**	**0.10**
		Average of yearly averages:				**0.13**

APPENDIX V. Overview of Risk Quotients (RQs)

Risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The means of this integration is called the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by acute and chronic ecotoxicity values.

RQ = EXPOSURE/TOXICITY

RQs are then compared to OPP's levels of concern (LOCs). These LOCs are used by OPP to analyze potential risk to nontarget organisms and the need to consider regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories: (1) acute risks - regulatory action may be warranted in addition to restricted use classification, (2) acute restricted use - the potential for acute risk is high, but may be mitigated through restricted use classification, (3) acute endangered species - endangered species may be adversely affected, and (4) chronic risk - the potential for chronic risk is high regulatory action may be warranted. Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to insects, or chronic risk from granular/bait formulations to birds or mammals.

The ecotoxicity test values (measurement endpoints) used in the acute and chronic risk quotients are derived from required studies. Examples of ecotoxicity values derived from short-term laboratory studies that assess acute effects are: (1) LC_{50} (fish and birds), (2) LD_{50} (birds and mammals), (3) EC_{50} (aquatic plants and aquatic invertebrates) and (4) EC_{25} (terrestrial plants). Examples of toxicity test effect levels derived from the results of long-term laboratory studies that assess chronic effects are: (1) LOAEL or LOAEC (birds, fish, and aquatic invertebrates) and (2) NOAEL or NOAEC (birds, fish and aquatic invertebrates). For birds, mammals, fish and aquatic invertebrates the NOAEL or NOAEC generally is used as the ecotoxicity test value in assessing chronic effects, although other values may be used when justified. Risk presumptions and the corresponding RQs and LOCs, are tabulated below.

Table 1. Risk presumptions for terrestrial animals based on risk quotients (RQ) and levels of concern (LOC).

Risk Presumption	RQ	LOC
	Birds	
Acute Risk	EEC[1]/LC_{50} or LD_{50}/ft^2 or LD_{50}/day[3]	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
	Wild Mammals	
Acute Risk	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/ft^2 or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items
[2] mg/ft^2
[3] mg of toxicant consumed/day
LD_{50} * wt. of bird
LD_{50} * wt. of bird

Table 2. Risk presumptions for aquatic animals based on risk quotients (RQ) and levels of concern (LOC).

Risk Presumption	RQ	LOC
Acute Risk	EEC[1]/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOAEC	1

[1] EEC = (ppm or ppb) in water

Table 3. Risk presumptions for plants based on risk quotients (RQ) and levels of concern (LOC).

Risk Presumption	RQ	LOC
	Terrestrial and Semi-Aquatic Plants	
Acute Risk	EEC[1]/EC_{25}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1
	Aquatic Plants	
Acute Risk	EEC[2]/EC_{50}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1

[1] EEC = lbs ai/A
[2] EEC = (ppb/ppm) in water

Table 1. ISC Calculated Air Concentrations (µg/m³) At Selected Distances Downwind For Acute Exposure to Pre-Plant Agricultural Field Fumigations

Application Methods & Application Rate	EM Ratio	Field Size (Acre)	Downwind Distance. (M)	Differing Meteorological Conditions									
				1 m/s 2.3 mph	1.4 m/s 3.1 mph	1.8 m/s 4 mph	2.2 m/s 5 mph	2.7 m/s 6 mph	3.1 m/s 7 mph	3.6 m/s 8 mph	4.0 m/s 9 mph	4.5 m/s 10 mph	4.5 m/s 10 mph
				Stab D	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab B
Sprinkler Irrigation Standard Seal 320 lb/A	0.23	1	0	5089	2527	1966	1608	1310	1141	983	884	786	576
			25	1938	894	695	569	463	404	348	313	278	196
			100	856	361	281	230	187	163	141	127	112	67
			500	155	44	34	28	23	20	17	15	14	6
		10	0	7063	3405	2649	2167	1766	1538	1324	1192	1059	707
			25	3587	1619	1259	1030	839	731	630	567	504	354
			100	1992	867	674	552	449	391	337	303	270	185
			500	731	260	202	166	135	118	101	91	81	40
		40	0	8404	3974	3091	2529	2061	1795	1546	1391	1236	885
			25	4834	2145	1669	1365	1112	969	834	751	667	464
			100	3035	1298	1010	826	673	586	505	454	404	275
			500	1334	516	402	329	268	233	201	181	161	91
Sprinkler Irrigation, Intermittent Seal 320 lb/A	0.07	1	0	1507	748	582	476	388	338	291	262	233	170
			25	573	265	206	168	137	119	103	93	82	58
			100	253	107	83	68	55	48	42	37	33	20
			500	46	13	10	8	7	6	5	5	4	2
		10	0	2091	1008	784	642	523	455	392	353	314	226
			25	1061	479	373	305	248	216	186	168	149	105

Table 1. ISC Calculated Air Concentrations (µg/m³) At Selected Distances Downwind For Acute Exposure to Pre-Plant Agricultural Field Fumigations

Application Methods & Application Rate	EM Ratio	Field Size (Acre)	Downwind Distance. (M)	Differing Meteorological Conditions									
				1 m/s 2.3 mph	1.4 m/s 3.1 mph	1.8 m/s 4 mph	2.2 m/s 5 mph	2.7 m/s 6 mph	3.1 m/s 7 mph	3.6 m/s 8 mph	4.0 m/s 9 mph	4.5 m/s 10 mph	4.5 m/s 10 mph
				Stab D	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab B
			100	589	257	200	163	133	116	100	90	80	55
			500	216	77	60	49	40	35	30	27	24	12
		40	0	2488	1177	915	749	610	531	458	412	366	262
			25	1431	635	494	404	329	287	247	222	198	137
			100	898	384	299	245	199	174	149	134	120	81
			500	395	153	119	97	79	69	59	53	48	27
Shank Injection Standard Seal 320 lb/A	0.18	1	0	3844	1908	1484	1214	990	862	742	668	594	434
			25	1464	674	524	430	350	304	262	236	210	148
			100	646	272	212	174	142	124	106	96	84	50
			500	118	34	26	22	18	14	12	12	10	4
		10	0	5334	2572	2000	1636	1334	1162	1000	900	800	578
			25	2708	1222	950	778	634	552	476	428	380	268
			100	1504	654	510	416	340	296	254	230	204	140
			500	552	196	152	126	102	88	76	68	62	30
		40	0	63046	3002	2334	1910	1556	1356	1168	1050	934	668
			25	3650	1620	1260	1030	840	732	630	566	504	350
			100	2292	980	762	624	508	442	382	344	306	208
			500	1008	390	304	248	202	176	152	136	122	68

Table 1. ISC Calculated Air Concentrations (μg/m³) At Selected Distances Downwind For Acute Exposure to Pre-Plant Agricultural Field Fumigations

Application Methods & Application Rate	EM Ratio	Field Size (Acre)	Downwind Distance. (M)	Differing Meteorological Conditions									
				1 m/s 2.3 mph	1.4 m/s 3.1 mph	1.8 m/s 4 mph	2.2 m/s 5 mph	2.7 m/s 6 mph	3.1 m/s 7 mph	3.6 m/s 8 mph	4.0 m/s 9 mph	4.5 m/s 10 mph	4.5 m/s 10 mph
				Stab D	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab B
Shank Injection Intermittent Seal 320 lb/A	0.08	1	0	1662	826	642	526	428	372	320	288	256	188
			25	632	292	228	186	152	132	114	102	90	64
			100	280	118	92	76	62	54	46	42	36	22
			500	50	14	12	10	8	6	6	4	4	2
		10	0	2306	1112	864	708	576	502	432	390	346	250
			25	1172	528	412	336	274	238	206	186	164	116
			100	650	284	220	180	146	128	110	100	88	60
			500	238	84	66	54	44	38	34	30	28	12
		40	0	2744	1298	1010	826	672	586	504	545	404	288
			25	1578	700	544	446	364	316	272	246	218	152
			100	992	424	330	270	220	192	164	148	132	90
			500	436	168	132	108	88	76	66	60	52	30
Drip Irrigation Tarped Field 320 lb/A	0.02	1	0	729	362	282	230	188	164	140	126	112	82
			25	276	128	100	82	66	58	50	44	40	28
			100	122	52	40	32	26	24	20	18	16	10
			500	22	6	4	4	4	2	2	2	2	0
		10	0	1012	488	380	310	252	220	190	170	152	110
			25	512	232	180	148	120	104	90	80	72	50
			100	284	124	96	78	64	56	48	44	38	26

Table 1. ISC Calculated Air Concentrations (µg/m³) At Selected Distances Downwind For Acute Exposure to Pre-Plant Agricultural Field Fumigations													
Application Methods & Application Rate	EM Ratio	Field Size (Acre)	Downwind Distance. (M)	Differing Meteorological Conditions									
				1 m/s 2.3 mph Stab D	1.4 m/s 3.1 mph Stab C	1.8 m/s 4 mph Stab C	2.2 m/s 5 mph Stab C	2.7 m/s 6 mph Stab C	3.1 m/s 7 mph Stab C	3.6 m/s 8 mph Stab C	4.0 m/s 9 mph Stab C	4.5 m/s 10 mph Stab C	4.5 m/s 10 mph Stab B
			500	104	38	28	24	20	16	14	14	12	6
		40	0	1204	568	442	362	296	256	1222	200	178	126
			25	690	306	238	196	158	138	120	108	96	66
			100	434	186	144	118	96	84	72	64	58	40
			500	190	74	58	46	38	34	28	26	22	12
Drip Irrigation Untarped Field 320 lb/A	0.01	1	0	259	128	10	82	67	58	50	45	40	29
			25	99	46	35	29	24	21	18	16	14	10
			100	44	18	14	12	10	8	7	6	6	3
			500	8	2	2	1	1	1	1	1	1	0
		10	0	359	173	135	110	90	78	67	61	54	10
			25	183	83	64	53	43	37	32	29	26	18
			100	102	44	34	28	23	20	17	15	14	9
			500	37	13	10	8	7	6	5	5	4	2
		40	0	427	202	157	129	105	91	79	71	63	45
			25	247	109	85	70	57	49	43	38	34	24
			100	155	66	52	42	34	30	26	23	21	14
			500	68	26	20	17	14	12	10	9	8	5

APPENDIX VI. REFERENCES

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